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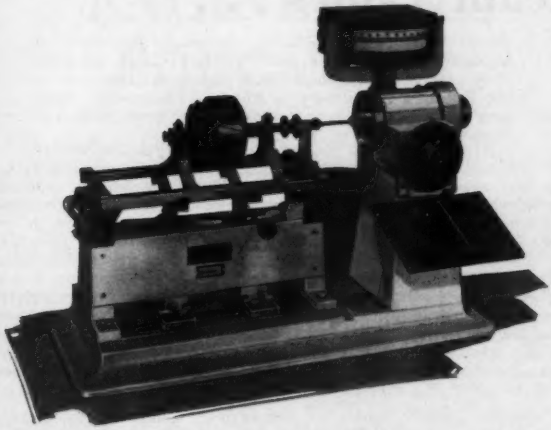

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GRADUATE STUDY

By H. P. HAMMOND

President of the Society

On the following pages there appears a series of papers, presented at the annual meeting of 1936, dealing with various aspects of graduate study in engineering. At about the same time a bulletin is being issued by the United States Office of Education which embodies the report on the comprehensive study of graduate work that has been conducted during the past two years in cooperation with this Society. The purpose of these papers and report is to furnish a body of information and opinion relating to this phase of engineering education. It is opportune that they should appear at this time, since a number of problems of far-reaching importance are pressing for solution.

It is a curious fact that the most rapid growth of graduate work has taken place during a period of great financial stress; while resources have been drastically limited the colleges have had to meet an insistent demand for expansion of the most expensive portion of their programs. Some of our present problems are due in greater or less degree to this anomalous situation. Others, equally important, are those that would accompany a process of expansion under whatever circumstances it might take place, that would pertain to any normal evolutionary change.

To give point to these remarks one or two of these problems may be stated:

A tendency is observed to adopt academic procedures and requirements employed traditionally in the older fields of philosophy and pure science with little question as to their validity in engineering education. To what extent and in what directions should we have courage to pioneer in developing methods adapted to our own unique requirements?

What selective processes of admission may be developed in order to guard against the danger of dilution of the quality of students pursuing graduate work that might accompany rapidly expanding enrollments?

How may the aim of conducting graduate work essentially as self-directed effort with emphasis on the development of ability to do original work be realized in the face of the observed tendency

to carry over into graduate programs the conventional methods of instruction employed in undergraduate work?

To what extent is it desirable to promote coöperation among institutions with the purpose of aiding in the development of distinctive programs of advanced work and research and so as to avoid needless duplication of effort?

The statements of fact and opinion embodied in the papers and report to which reference has been made, while valuable in themselves, can not provide the solutions to these problems; they can merely aid in the process of rational analysis that should constitute the approach to their solution. Nor is it intended that their appearance should mark a terminal point in the Society's work in this field. It is expected, on the contrary, that the studies of graduate work inaugurated by Dean Kimball's committee five years ago, and continued by the committee under which the recent survey has been made, shall be carried further. To that end a new committee, under the chairmanship of Dean Agg, has been appointed. It is hoped that the members of the Society will not only coöperate with this committee in the program of work it will undertake, but that there will be, independently, general discussion of the problems of graduate study during the year.

CONFERENCE ON GRADUATE STUDY *

ADMINISTRATION OF DOCTORATES AND MASTERATES

By C. C. WILLIAMS

President, Lehigh University

Although the two graduate degrees have come to have rather widely different significance, they grew out of the same original meaning. Either meant a teacher's degree, *master* or master in one locality, *doctor* or doctor in another, being used for an advanced teacher. Gradually the two degrees have drawn apart and quite generally to-day, the masterate is conferred at the conclusion of one or two years, while the doctorate is given after two or three years of study following the baccalaureate degree. The conditions vary widely in the award of these degrees.

With regard to the form of the doctorate, the Ph.D. as the highest degree in course commonly prevails regardless of the field of study. At least eleven institutions in the United States, six of which are members of the Association of American Universities, use the Sc.D. for engineering. Harvard and M.I.T. are included in this group. Some, *e.g.*, Pennsylvania, use the form D.Sc. in C.E. Others, including Hopkins and Rensselaer, use the D.C.E. The German Ing.D. is, in general, not a course degree, but is awarded on the basis of experience and a research thesis.

The doctorate has lost any particular content significance. It stands for a certain type of academic training, essentially intensive in character and involving a certain amount of research. If philosophy retains its original broad significance, *love of learning*, the Ph.D. degree is entirely appropriate for designating this type of training. Moreover, the forms D.Sc., D.Eng., D.C.E., etc., have been so widely used as honorary degrees that the Ph.D. remains as the only form that has a definite course significance.

Candidates for the doctorate should be admitted with a distinct formality in order to avoid embarrassment and misunderstandings. Only graduates of superior capacity, perhaps in the top fourth of their class, should be admitted as candidates for the doctorate, because otherwise, neither the students nor the institution will find the large amount of time and funds profitably spent; and students

* Papers presented at 44th Annual Meeting, S. P. E. E., University of Wisconsin, June 23–26, 1936.

of less ability will seldom do work of a proper doctorate standard.

Most institutions require a minimum of essentially three years of residence study for the doctorate, the last of which at least must be spent at the institution giving the degree. Graduate credits are not generally transferred from another institution except as they may be validated by the school receiving them. Fragmentary and old credits (more than five years) are commonly discounted in fulfillment of course requirements.

While departmental boundaries are commonly lowered in doctoral study so as to permit clustering all work available in the institution directly pertinent to the major effort of the individual student, yet practical administration necessitates the assignment of the *major* in one department. Whether or not formal minors are adopted is a variable custom. My own preference is to make the election of a formal minor optional and, if elected, to require it to be a significant part of the training, perhaps a fifth or sixth of the total graduate program, especially if the minor is to be recorded on the diploma given.

It is important that the doctorate be awarded by the graduate faculty, or the graduate school, of the entire university, rather than by a department or division, lest a diversity of standards should arise. This is particularly important for colleges of engineering whose faculties seldom number many who have had the formal doctoral training found in the older departments of the arts and sciences, most engineering professors of to-day having acquired their advanced knowledge through self direction, and their recognition from their profession rather than from a college faculty.

The language requirement of two modern foreign languages is fairly uniform and is most commonly administered by the language departments. However, in some institutions, the major department passes on the language proficiency, a custom which would seem questionable because of the danger of making the requirement perfunctory and feeble. At Lehigh the certification is jointly from the language department involved and the department of the student's major, a custom that seems to have advantages.

The dissertation, which usually constitutes about one-third of the doctoral work, should give evidence of research ability and preparation, and should actually make some progress in original contribution. It is the essential feature of the candidate's qualification for the degree. The requirement that the thesis, or an abstract, be printed is quite common, if not universal.

The preliminary or qualifying examination, commonly given one year prior to the time of awarding the degree, should be the

main test of the candidate's mastery of preparation. The examining committee should be fairly large and include professors from cognate departments as well as from the major department. It should particularly include representatives from the minor departments. The examination should be both written and oral and should be searching, for it is at this point that unworthy candidates should be eliminated rather than at the final examination. The committee members should record independent votes either by ballot or by signature on a form report.

The final examination is confined largely to the major and to the dissertation. It should be open to any members of the faculty interested and the examining committee should again be representative of related departments. Again the ballot should represent an independent vote.

The master's degree has been rather widely conceived in past years as a "little doctorate," standing for intensive study and research, but only about one-third as much as the doctorate. The tendency now seems to be to make the master's study somewhat more comprehensive rather than intensive, and to remove any fundamental research from the requirements. In many institutions, a thesis is optional. Where required, the thesis is commonly limited to about one-sixth of the total program of study. With the growth of the usable science in engineering, the one year of graduate study seems best suited to advanced study in courses rather than to attempts at research in fields already largely explored or which require much more time than is available. The master's thesis seems to be subjected to much the same pressures which caused the senior theses of two decades ago to be abandoned.

Examinations for the masterate should be of a comprehensive character and should be both written and oral. The committee may properly consist of about three professors. The master's examination should not be accepted generally as the qualifying examination for candidacy to the doctorate because of the essential difference in purposes of the examinations.

SELECTION OF SUBJECT MATTER FOR GRADUATE STUDY

By M. L. ENGER

Dean, University of Illinois

It is generally agreed that graduate study should develop the student's capacity for independent work and give him training in the methods of research. The principal aim of graduate work is to prepare the student for self-education. The difference between work on the undergraduate and graduate levels is one of emphasis,

The emphasis in undergraduate work is on the acquisition of information. For this purpose short lessons in text books and numerous assigned problems have been found effective. In graduate study the acquisition of information becomes of secondary importance. Here the emphasis should be on a critical study of the underlying assumptions and on the limitations which result.

Only a superior student should be encouraged to go on to graduate work. He should have a background of general information and the intellectual capacity required for intensive and individual study of a restricted field. For such a student courses on the undergraduate level would probably be unprofitable.

For best results graduate courses should be directed by teachers who are themselves productive workers in their fields of study. The importance of the personality and intellectual stature of the teachers cannot be overemphasized. Under favorable conditions the student and the teacher become co-workers and the student has every opportunity for growth and development.

Graduate study should lean heavily on the library and the laboratory. The historical development of the subject of study should be obtained from original sources as far as possible. The text book has an unimportant place in graduate courses. The selection of subject matter for graduate study must depend primarily upon the teachers available but the library and laboratory facilities must also be considered.

QUALIFICATIONS OF TEACHERS FOR GRADUATE WORK

By T. R. AGG

Dean, Iowa State College

The following statement outlines briefly certain considerations that appear to be important in the designation of members of the staff to teach those engineering subjects offered for major graduate credit.

1. The selection of teachers for graduate subjects in engineering should primarily be a responsibility of the administrators in the engineering college, usually the head of a department and the dean of the college, since these are best qualified to appraise the ability of the individual to direct the work of graduate students. Frequently the selection must meet certain formal institutional requirements but these should never be so rigid as to prevent the appointment of qualified persons to handle engineering graduate subjects. The requirement most likely to cause difficulty is that with respect to advanced degrees, particularly the doctorate. While the number of engineering teachers who have such degrees

is increasing each year, it still remains true that many of the most gifted teachers in the engineering field do not have such degrees.

2. Assignment to teach subjects accepted for major graduate credit presupposes mastery of a particular field of engineering knowledge, including, as a rule, not only the theory and principles involved, but also their applications in accepted engineering practice. In many instances industrial or construction experience is of far greater value to the teachers of such subjects than formal training above the undergraduate level. But formal training at the graduate level plus engineering experience form an invaluable background for the teacher of graduate subjects.

In some fields of engineering, excellent graduate instruction can be given without a background of engineering experience if the teacher has the proper scholastic training. The trend appears to be toward this type of graduate instruction in preference to that which involves applications in the applied field. This may be unfortunate unless extreme care is exercised to give the work a distinct engineering setting and to avoid paralleling graduate work in science.

3. The leader of graduate students must needs be a productive scholar and active in his professional field. Generally he will have to his credit publications dealing with his researches and his contributions to thought on the current problems of the profession.

4. Teachers of graduate subjects should possess the ability to guide students into channels in which they are capable of doing acceptable scholastic work largely on their own initiative and to direct their research projects without actually doing the work for them.

5. The personal characteristics desirable in teachers of graduate subjects do not differ greatly from those required for effective undergraduate teaching. However, the general plan that seems most effective for graduate work contemplates much less frequent contact between teacher and student than in the undergraduate program. Willingness to devote time to conferences with the student about his progress and ability to inspire him to concentrated effort through these conferences and perhaps some formal lectures constitute the important personal characteristics of a good teacher of graduate students.

6. The leader of graduate students ought to be a mature teacher and in general members of the staff below the rank of associate professor should not be placed in charge of subjects offered for major graduate credit. Like all good rules this has occasional exceptions.

SUBSIDIZING OF GRADUATE STUDENTS AND USE OF SUCH STUDENTS AS INSTRUCTORS

By EDWARD BENNETT

Professor of Electrical Engineering, University of Wisconsin

Of the students enrolled for graduate work in the Engineering Colleges of the nation, a goodly number find it possible to attend only by reason of subsidies in the form of awards, fellowships, or assistantships of the following types.

	Number Awarded in U. S. Engineering Colleges 1933–34
a. Fellowships and scholarships which make no demands for service from the fellow save whole hearted application to graduate work	426
b. Research and industrial fellowships and assistantships which require specified part-time services on assigned research or testing	174
c. Teaching fellowships and assistantships which require part-time service in class or laboratory instruction	249
Total	849

These awards are all made to a highly selected group on the basis of demonstrated qualifications for advanced work in their respective fields. There can be no objection to subsidies of the first two types, provided the acceptance of funds for industrial fellowships is accompanied by appropriate safeguards. In fact, a fourfold increase in the moneys now available for the first two types of awards could be most effectively used and would in my estimation yield a rich social harvest. It is possible, if not probable, that the ultimate effect of a marked increase in the funds available for fellowships of the first two types would be to reduce the apparent necessity for fellowships of the third type.

The total amount available for all fellowships in the engineering colleges of the country during 1933–34 was $293,000, an average of $342 per fellowship, of which perhaps $90,000 was used for teaching fellowships.

This memorandum is not concerned with fellowships of the first two types, but deals with some aspects of the teaching fellowships. Mixed results flow from the use of teaching fellows and assistants. If I may quote in part from an earlier memorandum:

> From the standpoint of the needy graduate student who is enabled to go forward with his graduate work by reason of the salary from his part-time teaching assistantship, the teaching assistantship is a beneficent arrangement.

From the standpoint of the same man who enters the teaching field after obtaining a doctorate and then contends for years with a meager salary because of the competition of part-time assistants, there is much to be said for more comprehensive child labor codes.

From the standpoint of a department head, or an administrator, desirous of building up the graduate enrollment, the teaching assistantship is a helpful expedient.

From the standpoint of a teacher in the graduate school attempting to build upon, or to reconstruct, the faulty foundation resulting from the instruction of the teaching assistant, it is a questionable practice.

From the standpoint of the student, or the parent of the student, who falls in the section of the immature half-time assistant, the practice is a vicious practice.

From the standpoint of an administration concerned with the problem of legislative support, the teaching assistantship is likely to be a questionable expedient, because of the disaffection among constituents based upon the exercise of poor judgment by immature assistants.

The statistical information gathered by the Committee on Graduate Study indicates that 249 teaching assistantships in the engineering colleges of the United States is relatively small, constituting about 30 per cent of the 849 subsidized graduate students and about 9 per cent of the total number enrolled for graduate work in engineering. These percentages relate to conditions within the control of the engineering colleges, and they are a statistical average and are lower than in those institutions in which the teaching assistantship is more liberally used. Moreover, for those engineering colleges which are divisions of universities, the instruction of engineering students in the important fundamental subjects of mathematics, English, chemistry, and physics is commonly given in the College of Letters and Science. In these departments and for the undergraduate work the percentage of part-time graduate student assistants is much higher than in the teaching staffs of the engineering colleges.

In view of the questionable and conflicting aspects of the practice, and of the necessity for lending support to the forces working for more adequate financial support of instructional work in the fundamental introductory courses, it would seem that engineering colleges should guard against the subsidizing of graduate work by part-time teaching assistantships. In support of the practice of using the part-time teaching assistant to get the teaching done in the large classes in the important fundamental courses, it is frequently urged that the graduate part-time assistant, although inexperienced and lacking background, is nearer the student and therefore more effective than the old professor. This is to confuse the issue, since the comparison of the effectiveness of the part-time

graduate assistant and the older professors is not to the point. For the sake of the argument let it be granted that the part-time assistant is often more effective than the older professor. The elimination of the immature first and second year graduate assistant from the teaching staff does not contemplate that the teaching he is now doing will be taken over by old professors, but by young men who are not attempting to serve two masters and who have had the advantage of acquiring an appreciation of their subject under a more promising and rational apprenticeship.

The apprenticeship of the exploited part-time assistant is an apprenticeship to administrations and so it creates *expectations* which, if not fulfilled, lower the morale of the teaching staff. The apprenticeship of the prospective engineering teacher should be largely an apprenticeship to science and to masters of the arts and sciences,—an apprenticeship which creates, not *expectations,* but the sense of *obligation.*

It is possible that the budgetary limitations which seem to require the continuance of the practice of using part-time graduate assistants in legislatively supported institutions are not entirely imposed by legislative action. The limitations may be in part set by educators themselves by reason of their own inadequate or faulty views of the economically feasible. In a situation of this kind, judgments and policies relative to questions of this (economic) type would be strengthened if the university community were possessed of a thoroughgoing quantitative analysis of the facts about the resources of the commonwealth and the division of these resources between the educational and all the other interests of the commonwealth.

The term "interests of the commonwealth" is being used in the sense of "wants, desires, and aspirations." It is intended to embrace all those human activities and lines of endeavor which compete in the thoughts and plans of individuals, groups, and associations for their support. It is not limited to the interests in the goods and services which are bought by public expenditures but includes all those obtained by private expenditures. It includes such interests as the interest in housing, clothing, food, national and municipal police protection, conservation, medical service, travel, recreation, entertainment, news, public education, and in the investments for a future harvest, such as the investments in physical plant, new scientific knowledge, slowly acquired skills and insights, and in the development of altruistic and civic spirit.

Insight into the support of these diverse interests is to be had not alone from the dollar expenditures (public and private) made

annually by the citizens of the commonwealth for each of these diverse purposes, but also from the classified expenditures of human effort in man years of work.

A study of statistical data which penetrates beneath the surface indications and which presents the net expenditure (as variously expressed) for education or health or highways against the background of all the other expenditures may be termed—"A Study of Prevailing Patterns of Expenditure." Equivalent titles would be "A Study of Prevailing Patterns of Production," or "A Study of Prevailing Patterns of Consumption."

ESTABLISHMENT OF CENTERS OF SPECIALIZED RESEARCH

By F. T. MAVIS

Associate Director in Charge of Laboratory, Iowa Institute of Hydraulic Research; Professor and Acting Head of Mechanics and Hydraulics, State University of Iowa

Dr. Hans Detlef Krey, for many years director of the Prussian Experimental Institute for Hydraulic Engineering and Shipbuilding in Berlin, listed the essential elements of a center of specialized research in hydraulics about as follows: (1) several good heads, (2) adequate space and water supply, (3) some money, and (4) a little confidence. "This is all a new research laboratory needs by way of original endowment," he continued. "In establishing a research institute one should guard against the desire to build the laboratory as a fully complete unit ready to investigate any problem which may arise. Planned with this in view, the laboratory becomes a show place, not a workshop. Details to suit particular projects can be planned much better as problems are presented than they can be anticipated far in advance. . . . In a real laboratory as in a workshop all non-essentials and temporary accessories should be made in the simplest and cheapest manner. The most important apparatus, however, as well as the regulating and the measuring devices should be made with greatest care even if they are to be used for only one experiment or for one specific purpose. Probably all laboratories dealing with the problems of engineering practice have had the common experience that equipment and apparatus for every major investigation must be designed and assembled for that particular purpose and that they cannot be designed in advance to meet all needs."* While Dr. Krey's exposition of the essentials of a research institute loses much of its poignancy in being translated from the German, the sense of his comments is quite obvious.

* "Die Wasserbaulaboratorien Europas," pp. 196–197, V.D.I. Verlag, Berlin, 1926.

Personnel, plant, operating budget, and good will are certainly significant factors upon which the success of a center of specialized research depends.

To-day we think of engineering in its investigative, design, executive, and advisory phases as being rather the coördinated endeavor of specialists than the independent efforts of any one individual. To-day engineering projects are investigated, planned, constructed, and operated by staffs of technically trained men whose equal in coördinated capability and performance has probably never before been equalled. Surveys, investigations, designs, estimates, specifications, construction, and operation move forward in units as battalions in a well-trained army under able generalship.

For maximum effectiveness, a research institute is an organization of specialists and workers whose efforts are suitably coördinated. This organization through its individual members must possess a scholarly background in the special fields of research. Those responsible for major investigations and their respective subdivisions must be resourceful and they must have fertile imaginations. Further, they must have keen powers of observation and analysis, sound judgment, a balanced sense of values, and utter devotion to truth. In each member of the staff there should be a well-developed sense of responsibility and coöperation making for productiveness and high esprit de corps. The director of the organization must have executive and administrative ability, and often a masterful control of his emotions. An ill-timed reprimand or a tactless expression of impatience is so much grit in the gears of a fine mechanism. In the complex workings of a research organization, an ineffective cog can be quietly cleaned and oiled or even replaced without stopping or appreciably retarding the mechanism. Good judgment, a reputation for fairness and objectivity, and a genuine interest in the well-being of each member of a staff are, in my opinion, some of the essential personal qualities of the director and leaders in a research organization.

Investigations carried on in a research institute should be narrowly restricted in their objectives, they should stimulate the imagination, they should be adaptable to experiment, and they should be economically justified.

A major investigation must be broken down into projects sufficiently limited in scope that each can be viewed in its proper perspective. Little progress can be expected if the attacks are made along an entire front by a single unit of an offensive. Able generalship and concentrated attacks upon definite objectives gain ground in science's battle against the unknown. The project and the tools of the investigation should stimulate the imagination of the research worker. So far as practicable the long distance aims

of an investigation should be shared with each person in the organization giving due consideration to the breadth of his horizon. The routine of observation, computation, and tabulation, ceases to be drudgery if the man who does the work sees the importance of his job from an objective viewpoint. The project and the apparatus should provoke experiment. Experimentation in its broader sense includes not only the manipulation of test tubes, wires, gages, and meters, but also the study of complex inter-relationships of cause and effect by analysis and reasoning based upon valid hypotheses, and the establishment of new hypotheses based upon systematic observations of cause and effect. It is in this broader type of experimentation that the coöperation of scholar and observer, dreamer and realist, designer and analyst, director and staff, is essential for a smooth-working machine. The investigations, as a whole, should be inexpensive. If research in a given field of applied science is to receive the support of a materialistic society indefinitely the investigations in that field must be able to show an ever increasing net worth. Unfruitful investigations will not bankrupt an experimental science any more than unprofitable investments will wreck a business—provided they are not too numerous or too obvious.

What is the rôle of the research institute in relation to graduate study in engineering? Does the research institute so narrow the student's point of view that he loses a proper appreciation of engineering as a whole and of his relationship to the practice of engineering? On the contrary, in the Institute of Hydraulic Research graduate students and selected undergraduates have an opportunity to learn much more than the academic phenomena of water flowing. Although the work in the Institute deals largely with hydraulics, hydrology, fluviology, and hydromechanics, it is inseparably linked with structures, machines, and power transmission. Sanitary engineering with its water supply, sewerage, and waste disposal is so interlaced with hydraulic engineering as to be scarcely distinguishable from it in many quarters. Closely related and further entwined with hydraulic and sanitary engineering is the field of public health engineering. Indeed, a research institute need not produce narrow specialists who are not qualified beyond the limits of their specialty.

Often a student "finds himself" in the atmosphere of a research institute. As he works on a problem to which he may have been assigned, he becomes interested in certain ramifications which necessarily present themselves when he considers the practical significance of his investigation. A hydrologic study ceases to be a mass of statistical data and becomes a basis for designing a dam, a conduit, or a municipal water supply. A spillway becomes more

than a textbook figure or a discharge formula. First it assumes three dimensions in concrete and ultimately approaches full size in the consciousness of the student. The applications of hydraulics, mathematics, structural analysis, geology, and even mathematical physics to such a restricted research investigation are conducive to broadening the student's grasp of fundamentals as he concentrates upon a narrowly limited project.

In the atmosphere of a research institute the pupil is metamorphosed into the student. For years he has read textbook assignments and recited facts and opinions in a class with other pupils—recited textbook statements which presumably the teacher knew better than he. In the research institute he is assigned to a restricted project to discover new facts which his supervisor does not know. Assignments assume a certain worthwhileness. Questions seem intended to get at engineering facts and they lose that flavor of "how minutely did you study your assignment"? Answers are less reluctantly offered man-to-man than pupil-to-instructor before a critical or drowsy class. Indeed, if he has the innate ability, the student has a chance to learn, to observe, to do, and to be a responsible part of the research institute.

Basically the requirements of a center of specialized research may be few in number but they are great in importance. A competent staff, well organized and ably guided, and provided with reasonable facilities, can play a significant rôle in engineering education at the graduate level. At the training table of graduate students in engineering the center of specialized research may provide a tasty seasoning.

GRADUATE STUDY FOR DEGREES VS. NON-DEGREE OR SERVICE GRADUATE STUDY

By THORNDIKE SAVILLE

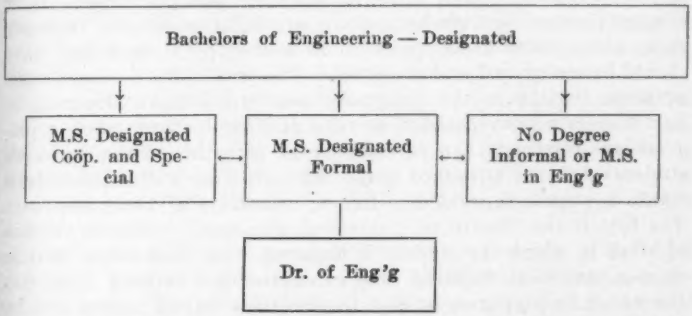
Dean, College of Engineering, New York University

In discussing the preliminary report of the committee on Graduate Study a year ago, President Wickenden remarked, "A four year undergraduate course rapidly is becoming totally inadequate as preparation for engineering service of a high professional type, yet it remains for the present a reasonably adequate basis for the great body of service activities for which young engineers are in active demand."

I believe that the committee on Graduate Study has agreed with this pronouncement, and in common with many other educators, regards study and research subsequent to receipt of the bachelor's degree as providing necessary facilities for those who have both

the desire and aptitude to prepare themselves more completely for professional service. However, the paths to be pursued in undertaking post-graduate work are to my mind not so simple as they have heretofore generally been regarded, namely, the prosecution of a more or less formal course of advanced study and research of a highly technical nature.

The committee has indicated that graduate study is in a period of flux, and that there is no single or best procedure yet developed to fit all or even a majority of students. It seems to me that the present situation in respect to graduate work may be illustrated diagrammatically thus:


Bachelors of Engineering — Designated
M.S. Designated Coöp. and Special
M.S. Designated Formal
No Degree Informal or M.S. in Eng'g
Dr. of Eng'g

The normal past procedure is shown in the central blocks, which is the formal, historic or classical type of graduate study. It has a more or less fixed curriculum, highly technical, few electives, is directed at specialization, and usually requires a thesis based upon research. Essentially, in most instances, so far as the master's degree is concerned, it is a continuation of the undergraduate curriculum, with slightly less formal teaching procedures.

Between 1912 and 1925, there developed a number of special procedures for advanced study, usually as a coöperative undertaking between a specific industry and a specific institution. Typical of these is the plan in effect between Massachusetts Institute of Technology and the General Electric Company. Variations of this plan adopted by other institutions are mentioned in the preliminary report of the Committee on Graduate Study. These procedures are illustrated in the left hand block of the diagram. Students participating in them usually receive the designated master's degree and can, of course, follow through to the middle block practices by appropriate adjustments in their courses of study.

The third procedure in graduate study, which I am particularly requested to discuss with you, is still in a developmental stage,

but seems to me to present great possibilities for usefulness. I brought it to your attention in discussing the preliminary report of the committee last year, and should like to develop those ideas a little more fully now.

There have grown up in a number of urban institutions large undergraduate engineering programs carried on in the evening, generally on a part time non-resident basis. Out of these has developed naturally a demand for graduate study on a similar basis. Up to the present, such graduate study has, in general, attempted to follow the historic middle course shown on the diagram. It is my feeling, based in large part upon my observations in New York City, that, while facilities for this part time, day or evening non-resident graduate study are highly desirable, there are three quite different purposes to be served by it, and that they should be recognized and discussed. The first is the normal formal program leading to the designated master's degree. Evening or part time students qualified to take and benefit from such a program are relatively few in comparison with the numbers of such students desiring advanced work. The great bulk of such students want, or should be guided to follow, either one of two procedures. The first is the pursuit of specialized advanced courses in the line of work in which the student is engaged. He finds either that he is in a somewhat different field of engineering activity from that for which he prepared, or that he needs specialized instruction for his special job, or that he requires from time to time an advanced review course to present in an orderly manner the advances in his special subject for a few years past.

The second procedure is even more of an adult education program than the first. It arises from the desire of a student to broaden his background, either in technical or in non-technical subjects. More and more employed engineers are taking evening courses in economics, finance, public administration, labor problems, current social philosophies, etc. Related practices are developing at other institutions by means of special advanced courses held at centers away from the institution, but conducted by the institutional staff and under institutional auspices.

I believe that these types of essentially service courses are highly useful, and of real need, and that they should be provided and indeed be developed for special purposes. But to my mind they are infrequently of real graduate calibre. Also, many of the class of students mentioned, take the so-called advanced specialized classes normally in the program for advanced degrees, and are not really competent to pursue them. They get too little from them, are over confident of their ability subsequently to undertake specialized work, and retard the fewer number of competent men in

the classes. Moreover, few of these men have time or can use the necessary facilities requested for research work in fulfillment of candidacy for a degree. Too few do creditable work of this kind.

I think one should seriously consider the service nature of courses used by the majority of the part time non-resident employed engineers. This may involve some segregation of post-graduate courses into those credited for a degree and those of a service nature.

Related to the informal or general character of service courses of an advanced nature are the growing number of summer institutes, special conferences, and the like, dealing with a special field (sometimes broad, sometimes restricted) of engineering, teaching, practice, or service. These also vary in calibre, participation at some being easily equivalent to graduate work of high character. Others are of a discursive, or general informative nature.

To separate in all of these desirable undertakings the degree value graduate work from what more properly belongs to a program of adult education is a difficult and perplexing task. It should be worked out experimentally, and will probably vary to meet the needs of different conditions in various parts of the country.

The problem is growing; it is important; it ought to be faced frankly. Engineering educators will be confronted increasingly with the need for providing both the degree type and the service type of graduate study. It is time that we began to evaluate the place of these in engineering education, lest we find ourselves shortly in the embarrassing position of attempting to compromise between two essentially different educational objectives. One is professional training; the other is adult education.

GRADUATE WORK IN ENGINEERING AND ECONOMICS

By EDMUND D. AYRES

Associate Professor of Engineering Economics, University of Wisconsin

I come to you with convictions. Convictions, arising out of two years careful study of the problem of educating the engineer in business and economics, make me plead for a broader outlook upon this problem and for an end to the haphazard approach that the engineering schools of today take in this matter. Time does not permit the spreading of detailed conclusions * before you now —but the gist of these convictions must precede the little I have to say about the graduate school.

* A formal report on these matters is planned for completion this coming fall semester.

First, this thing is a life matter not to be bound in within the narrow limitations of resident instruction at college. Second, the average engineer will probably continue to be satisfied with four years of undergraduate work, the privileged minority only, receiving five or more resident years in college. Third, the modern trend in engineering towards a professional consciousness, as exemplified in state registration and the activities of the Engineers' Council for Professional Development, is not likely to diminish, and if it did, the practical necessity for the organized approach to the problem is still there. This all supports the one thesis—you cannot expect many average engineers to emerge from engineering school with both adequate technical and business training—and yet in the practice of their profession comes the need for business and economics just as surely as death and taxes.

The natural and obvious solution to this problem of providing adequate training in business and economics for the average engineer is exactly the same one that anyone seeking the most instruction in an involved subject in the minimum of time would normally and naturally seek—an orientation or survey of the field followed by intense application of attention upon one division of the field after another. This solution can be pictured well as a wheel. For the student headed for research, this business study wheel can be a baby-buggy wheel, for the student headed for executive work by way of the technical engineering path it must be a wheel designed to take a heavy balloon tire. The survey course is the hub.

This hub has to be made of sturdy material and requires such a minimum of time as to be available to every engineering student. It should be elected by the student, and not required of him, when he comes to the realization of its purpose and its relation to his interests and needs. It should be taught in such an elementary manner as to serve as well if this realization comes to him as a freshman or not until five years or more after graduation. Its content should cover every important phase of business and economics that touches the average engineer's life, but it must be confined to fundamentals devoid of frills, designed to reflect the scope of commercial work with principles and information which will command the student's respect and feed his interest. To assure his opportunity to include it in his engineering course, or to give him a rapid orientation when practical problems crowd him after school—it must be confined to a three credit course extending throughout a year in resident instruction or the equivalent to this in extension or correspondence study, no more!

The spokes will be the paths of interest and emphasis which fit

the individual's outlook. For the ordinary engineer at least five spokes will nearly always be used: elementary economics, accounting, statistics, business law and marketing. Other spokes which may be used are elementary sociology, banking, labor and personnel management and so on.

The rim, which holds either a thin steel tire or a heavy pneumatic shoe, is the correlation and interpretation of the work making up the spokes. This rim must be the work of the individual whose wheel it is going to be, for the tread is going to be the individual engineer's point of contact with the other professions, with his business associates and with society in general, in matters ranging from business to politics.

Repeating the sense of the statement above, this wheel is not a product of the college entirely, it is the engineer's business from the day of matriculation in college until and after he is accepted as a valuable member of the engineering profession. *It is the business of the engineering college* to organize this work so as to administer and aid in its design and construction over this same life period, and there is no dodging this obligation ultimately.

Now, as to graduate work, the primary purpose of graduate work, even as it is the primary purpose of undergraduate work, is to teach engineering. The plan of graduate study should be focused to this end, but every hour of the graduate year which is not consumed with valuable technical work, I maintain, should be devoted to the construction of the business study wheel. For some students the wheel should be the predominating business of the student in his graduate year—with engineering diluted too far should come a new degree, a Master's Degree in Engineering and Economics or such title.

There is another aspect of the problem with which I am dealing. Due to lack of time I must neglect that aspect here. It is graduate work for a student whose technical course has been diluted to an end point of a bachelor's degree in administrative engineering or similar title meaning the same or nearly the same thing. I hope there will be discussion of that quite different problem by some of the other men at this conference.

REPORT OF CONFERENCES *

CHEMICAL ENGINEERING EDUCATION

Two sessions of the third conference on chemical engineering education, held on Tuesday, under the direction of the Chemical Engineering Education Committee were devoted to papers on the chemical engineering curriculum, the field of comprehensive problems for chemical engineering teaching, the inclusion of instruction on patent law for chemical engineers, and the question of utilizing a summer session for the chemical engineering unit operation laboratory. At the Wednesday afternoon and Thursday morning sessions, in charge of the Laboratory Committee, a symposium on procedures for chemical engineering unit operation laboratory experiments was held. Reports on the laboratory study of major unit operations were presented by individual members of the Laboratory Committee. Presiding officers during the conferences were Professors F. C. Vilbrandt (V. P. I.), W. W. Hodge (West Virginia), J. H. James (Carnegie Tech) and H. McCormack (Armour). In the absence of Professor J. C. Elgin (Princeton), Professor J. C. Whitwell (Princeton) served as secretary of the conference. A conference dinner and informal luncheon and dinner gatherings of the group were also held.

During the conference the formation of a Chemical Engineering Division was proposed, and permission to do so was granted by the Council of the Society. The permanent status of the chemical engineering conferences is, therefore, assured.

The total attendance at the present conference of fifty-three, representing thirty-four universities and colleges and four industrial interests, constitutes the largest group yet attending these conferences.

Papers and Reports

Tuesday Afternoon.—At the opening session Professor Vilbrandt, Chairman of the Chemical Engineering Committee, outlined the conference program. Papers on "The Trend in Emphasis on Chemical Engineering and Chemical Courses," by J. L. Bray (Purdue), and on "Time Allotted to Chemical Engineering Subjects in Various Schools," by E. E. Randolph (North Carolina

* Held in connection with the 44th annual meeting, S. P. E. E., University of Wisconsin, Madison, June 23–26, 1936.

State), dealing with the composition of chemical engineering curricula, were presented. Professor Bray pointed out the considerations involved in formulating the revised chemical engineering curriculum at Purdue University, emphasizing the reappointment of the time allotment for the several chemistry courses, and changes in type of electives. Professor Randolph gave a statistical survey of the distribution of chemical engineering subjects in the various schools in the United States granting the baccalaureate degree in chemical engineering. In the discussion of his paper, Professor Bray stated that the complete freedom in choice of electives now permitted at Purdue resulted in the selection of these largely from technical fields. Professors M. C. Molstad (Yale), J. H. James, and Mr. Atkinson (Procter and Gamble) deplored this apparent tendency away from cultural engineering. Professors Bray and R. N. Shreve (Purdue) and R. A. Baxter (Colorado School of Mines) felt that technical subjects were of the first consideration, Professor Shreve pointing out that the personality and characteristics of the professor in charge could compensate for the failure to elect cultural subjects. Professors Hodge, W. L. Faith (Kansas State), O. R. Sweeney (Iowa State), and A. M. Max (Wisconsin) contributed to the discussion. Replying to Professor Vilbrandt's request for a discussion of the reduction in the time allotted to analytical chemistry and the placement of organic and physical chemistry earlier in the curriculum, Professor Whitwell described the practice at Princeton, where this has been in effect for several years with very satisfactory results. Professor H. S. Lukens (University of Pennsylvania) agreed as to the desirability of this procedure.

Two papers dealing with comprehensive problems, "The Value and Functioning of Chemical Engineering Comprehensive Problems," by J. H. Koffolt (Ohio State), and "Typical Comprehensive Problems," by O. A. Hougen (Wisconsin), were next presented. These illustrated the types of such problems available and several typical problems which have been satisfactory at Wisconsin. Discussion of these papers dealt primarily with time requirements where comprehensive problems were included and their proper placement in the curriculum. In reply to questions by Professors R. C. Kintner (Bucknell), Koffolt, and Vilbrandt, Professors O. A. Hougen and O. L. Kowalke (Wisconsin), J. H. Rushton (Drexel Institute), and A. M. White (University of Virginia) reported on the time required and the provision for it in the case of comprehensive problems assigned to their students. It was the concensus of opinion that regular class exercises in chemical engineering courses must be suspended if comprehensive problems

are to be assigned. Professor McCormack stated that any laboratory report may be, and usually is, a comprehensive problem. Disapproval of the type of problem involving plant design was expressed by Professor C. P. Baker (Northwestern), based on his industrial contacts. Professors Hodge, G. C. Williams (Mississippi State) and Dr. F. Bebie (St. Louis, Missouri) also participated in the discussion.

Three papers, "Patent Law Instruction for Chemical Engineers," by J. H. James, "Patent Information Needed by Chemical Engineers," by O. R. Sweeney, and "Patent Courses in the Chemical Engineering Curriculum," by J. R. Withrow (Ohio State) (read by Koffolt), dealt with the importance of elementary instruction in patent law and the type of patent information desirable for students. The view was expressed that, for undergraduates, patent instruction could well be included in existing courses and that a short graduate course on this subject was desirable. Professor McCormack preferred to omit patent law instruction entirely unless a thorough training could be given as he felt superficial knowledge to be dangerous in the field.

Professors C. C. DeWitt (Michigan College of Mining and Technology), Koffolt, McCormack, and Kowalke stressed the importance of such practical aspects of a patent knowledge as the advantages of keeping a correct record in a dated and witnessed notebook, the necessity for the formulation of a workable patent, and appreciation of a company's rights in the matter of employees' inventions and ideas. Available texts were discussed by Professors Shreve and Sweeney. The need for graduate patent training of chemical engineers was brought out by Professors Vilbrandt, Sweeney, Shreve, and Dr. Bebie.

Tuesday Evening.—A joint meeting with the conference on Engineering Economy was also scheduled as alternate to this session of the regular conference on the Summer Session Laboratory.

Three papers were presented at the chemical engineering conference session: "The Summer Session Laboratory at Ohio State University," by J. R. Withrow (read by Koffolt), "The Bucknell Summer Practice Course," by S. C. Ogburn, Jr. (read by Kintner), and "The New Summer Practice Course at Purdue," by J. L. Bray. These speakers described the advantages obtained by giving the chemical engineering laboratory course during the summer, under the conditions existing at their respective institutions, and outlined the composition and administration of such courses. In reply to Professor H. L. Coles (University of Detroit), student time requirements in and outside the laboratory in connection with such courses were described by Professors Koffolt, Bray, Kintner,

and Kowalke. There was a diversity of opinion as to the desirability of requiring work outside the 8-hour period regularly scheduled for such courses.

Wednesday Afternoon and Thursday Morning.—These sessions were devoted to a symposium on laboratory procedures for chemical engineering laboratory experiments under the supervision of the Chemical Engineering Laboratory Committee. Twelve papers, as follows, each dealing with one of the more important unit operations, and prepared by a member of the Chemical Engineering Laboratory Committee, were presented:

Flow of Heat—H. McCormack, Armour Institute of Technology.
Flow of Fluids—J. H. Rushton, Drexel Institute.
Drying and Humidity—O. A. Hougen, University of Wisconsin.
Evaporation—J. H. James and A. H. Weitz, Carnegie Institute of Technology.
Distillation—J. R. Withrow and J. H. Koffolt, Ohio State University.
Gas Absorption—J. C. Elgin and J. C. Whitwell, Princeton University.
Mixing and Agitation—A. M. White, University of Virginia.
Filtration—G. H. Montillon and B. F. Ruth, University of Minnesota.
Size Reduction of Solids—L. T. Work, Columbia University (read by P. M. Horton, Louisiana State University).
Classification and Concentration—H. T. Ward, Montana State College.
Furnaces and Pyrometry—W. L. Bueschlein, University of Washington (read by R. A. Ragatz, University of Wisconsin).
Process Development—S. C. Ogburn, Jr., Bucknell University (read by R. C. Kintner, Bucknell).

These papers represented comprehensive reports on the laboratory study of the individual unit operations compiled and selected from a survey and study of available laboratory procedures, carried out by the committee members during the preceding year. No copies of these papers are available to the Secretary for general distribution and they must be obtained by addressing the individual authors. No definite plans for their publication have been made.

In general, these papers outlined the requirements for satisfactory and complete study of the operation in question, types of laboratory equipment necessary, type of data, methods of calculations and correlation, and presented experimental programs or procedures as a guide to experiments dealing with the operation. In each case, mimeographed copies of the complete report were

supplied to those in attendance, its presentation to the group being confined to a ten-minute summary, due to time limitations.

Business of the Conference

The Tuesday evening and Thursday morning sessions and the Conference Dinner were concluded by short meetings for the transaction of several important items of business before the conference.

After a review of the chemical engineering conference situation which involved the annual appointment of a Chemical Engineering Committee, Professor Vilbrandt pointed out the advantages in permanence, unity, and continuity which would result from the organization of those interested in chemical engineering into a division of the Society. A motion by Professor Shreve that a request for permission to form a Chemical Engineering Division of the S. P. E. E. be transmitted to the Council for immediate action, was unanimously passed by the conference. A constitution for the division was adopted and accompanied the request to the Council. A nominating committee, Professor H. S. Lukens, Chairman, was appointed to report at the Conference Dinner on Wednesday evening, at which time officers of the proposed division were to be elected.

At the Conference Dinner, Professor Vilbrandt reported favorable action by the S. P. E. E. Council on the request for permission to form a Chemical Engineering Division. Acceptance of the report of the Nominating Committee by the Division placed in nomination for 1936–37 the following names, for:

Chairman—F. C. Vilbrandt, Virginia Polytechnic Institute.
Vice-Chairman—J. H. James, Carnegie Institute of Technology.
Secretary-Treasurer—J. C. Elgin, Princeton University.

The report of this committee concluded with the statement that these nominations be regarded as an expression of approval and appreciation of the work of the past year's officers. A motion by Professor Shreve that the acting secretary be instructed to cast a single ballot for these men was unanimously carried. Upon motion by Professor Shreve, a $1.00 assessment of dues from Division members to provide for secretarial expense was voted, the assessment of such dues being authorized by the Constitution.

Upon recommendation by Chairman Vilbrandt, the Division voted to retain the Laboratory Committee as at present constituted. On account of Professor S. C. Ogburn, Jr.'s resignation from the Committee, Professor H. McCormack was elected to succeed to the chairmanship. It was decided by the Division that the Laboratory Committee should continue to work along the present lines, ex-

panding and clarifying the reports on those unit operations least developed, and investigating the inclusion of additional operations for the next meeting of the Division.

The advisability of publishing a laboratory manual, based upon the present reports, after suitable editing, was discussed at great length, a wide diversity of opinion being expressed. Other methods of making available present and subsequent reports of the Laboratory Committee to those interested were simultaneously considered. The type and composition of a book desirable for laboratory use were also discussed, no definite decision being reached. It was suggested that the type of book under consideration, and apparently desired by the majority of members, was a laboratory handbook, rather than a manual. Although it was generally agreed that publication of a laboratory guide of some description was to be desired, the sense of the Division was that the material embodied in the present reports was not yet in suitable form to provide for publication of a book. Hence, it was voted by the Division that the present reports should be edited by an editorial board, consisting of Drs. McCormack, Hougen and Montillon, the board to submit the material as edited to the membership of the committee, and when approved to be distributed as mimeographed material to the chemical engineering Division for use and study, report to be made by the recipients of the handbook material at the next meeting of the Division. Professors Vilbrandt, Hougen, White, Kintner, Horton, Weber (Iowa State), Koffolt, Molstad, Coles, Fisher (University of Louisville), Koehler (West Virginia University), Lukens, and Baker participated in the discussion.

Chairman Vilbrandt brought up for consideration possible subjects for discussion at the next meeting of the Division, which included suggestions for comprehensive problems, examinations, and further conferences with Engineering Economy and other groups. He requested that any additional suggestions be submitted to him by November, 1936.

A motion, expressing the appreciation of the Division to the Society, the officers of the Division, the chemical engineering committees, the University of Wisconsin and its Department of Chemical Engineering, was unanimously carried.

FRANK C. VILBRANDT, *Chairman*

SUMMER SESSION IN ECONOMICS

The S. P. E. E. Summer Session in Economics was held at the Stevens Engineering Camp at Johnsonburg, N. J., June 28 to July 5, 1936. It was associated and conducted concurrently with the Stevens Sixth Annual Economics Conference for Engineering Alumni.

Program

The program of both conferences consisted of two morning classes and an evening lecture. The morning courses of the S. P. E. E. Session included sequential lectures in Economic Theory and Engineering Economy. Those of the Annual Economics Conference included Production Management and Industrial Psychology. The evening lectures were attended jointly by both groups.

The following is a summary of the morning courses:

Economic Theory 1st Hour: 8:45 to 10:15 A.M.

Organized by Professor Horace Taylor of Columbia University; and conducted by Mr. Raymond J. Saulnier of Columbia.

Concepts of value; demand and supply; competitive prices; overhead costs; monopoly prices; returns to factors of production; effect of money and credit on prices; economic fluctuations.

Production Management 1st Hour: 8:45 to 10:15 A.M.

Conducted by Professor George W. Barnwell of Stevens Institute of Technology.

Plant location and layout; power, light and air conditioning; materials handling and storeroom control; standards and inspection; planning, scheduling, routing and job analysis; charts and statistical methods; the determination of economic manufacturing quantities.

Industrial Psychology 2nd Hour: 10:30 to 12:00 A.M.

Conducted by Professor Walter Van Dyke Bingham of Stevens Institute of Technology.

Job analysis, personnel selection and training; developing foreman and supervisors; accident reduction; monotony and fatigue; fore-stalling grievances, building morale; conducting negotiations with employees; studying consumer demand.

Engineering Economy 2nd Hour: 10:30 to 12:00 A.M.

Organized by Professor W. D. Ennis of Stevens Institute of Technology, and conducted by distinguished lecturers from four colleges and two industrial firms.

Increment costs; plant extension policy; depreciation; obsolescence; the tangibles and intangibles in engineering choice.

The schedule of evening lectures was as follows:

The Engineer and the New Society—Norman Thomas
Money—Ray B. Westerfield, Professor of Political Economy, Yale University
Labor Relations—Leo Wolman, Professor of Economics, Columbia University

Human Relations in Industry—T. North Whitehead, Assistant Professor of Business, Harvard University

Economics and Engineering—Harold G. Moulton, President, The Brookings Institution

After All, It is an Engineering Course—William McClellan, President, Potomac Light & Power Company

After All, Engineers Have to be Human Beings—Harvey N. Davis, President, Stevens Institute of Technology

Full details of the Day-by-Day schedule were published in the JOURNAL OF ENGINEERING EDUCATION, June, 1936.

ENROLMENT

A total of 77 persons were enrolled for both sessions, 39 for the S. P. E. E. conferences and 38 for the Engineering Alumni conference. A summary of enrolments is as follows:

S. P. E. E.	
(*a*) Full time enrolments	35
(*b*) Lecturers, not registered for courses but attending part time	4
Alumni Group in Economics Conference	
(*a*) Full time enrolments	26
(*b*) Part time enrolments	12
Total	77

Since the two sessions ran concurrently, there were four courses available for election in the morning hours; each member of either group could elect two of these four courses. Each course consisted of seven lectures. The selections made were as follows:

MORNING COURSES ELECTED (SEVEN LECTURES EACH)

Subject	Lecturer	S. P. E. E. Group	Alumni Group	Total
1. Economic Theory	R. J. Saulnier	30	11	41
2. Production Management	G. W. Barnwell	5	15	20
3. Indus. Psychology	W. V. Bingham	12	11	23
4. Engrg. Economy	W. D. Ennis and Others	23	15	38
		70	52	122

Attendance at the Evening Lectures was between 75 and 85, including members of the staff.

Twenty-five colleges and universities were represented by faculty and staff members of the S. P. E. E. sessions.

Organization

The S. P. E. E. program was arranged by a committee appointed to coöperate with Stevens Institute of Technology and was administered by W. D. Ennis, whom the committee appointed Director of the Curriculum.

Members of the S. P. E. E. Committee:

O. W. Eshbach, Chairman
A. R. Cullimore, Vice-Chairman, President, Newark College of Engineering
Harvey N. Davis, Chairman of Attendance Committee, President, Stevens Institute of Technology
E. L. Grant, Stanford University
H. P. Hammond, Polytechnic Institute of Brooklyn
D. S. Kimball, Dean, Cornell University
P. T. Norton, Jr., Chairman of Camp Committee, Virginia Polytechnic Institute
Walter Rautenstrauch, Columbia University
J. W. Roe, New York University
R. A. Seaton, Dean, Kansas State Agricultural College

Staff and Faculty

W. D. Ennis, Director of Curriculum, Stevens Institute of Technology
Eugene H. Fezandie', Camp Executive, Stevens Institute of Technology
Horace Taylor (Supervising), Assistant Professor of Economics, Columbia University
Raymond J. Saulnier, Instructor in Economics, Columbia University
Laurence E. Frost, Consolidated Edison Company of New York
Eugene L. Grant, Associate Professor, Stanford University
J. R. Shea, Western Electric Company
Paul T. Norton, Jr., Professor, Virginia Polytechnic Institute
Walter Rautenstrauch, Professor, Columbia University
Ray B. Westerfield, Professor of Political Economy, Yale University
Norman Thomas
Leo Wolman, Professor of Economics, Columbia University
T. North Whitehead, Assistant Professor of Business, Harvard University
Harold G. Moulton, President, The Brookings Institution
William McClellan, President, Potomac Light & Power Company
Harvey N. Davis, President, Stevens Institute of Technology

ELECTRICAL ENGINEERING

Tuesday, June 23.—After brief announcement by the Chairman in explanation of the prepared program the first paper, "A New General Engineering Curriculum," was presented by Professor Naeter of Oklahoma A. and M. College in a 20-minute digest. A 20-minute general discussion followed to which Professors Saxton and Thuesen of Oklahoma A. and M., Bauer of Northwestern, Pender of Pennsylvania, Dow of Michigan contributed. The discussion was closed by Professor Naeter.

The second paper, "An Alternate Method for the Conduct of an Electrical Engineering Course," was read by title in the absence of the author.

The first subject for general discussion, "Text-book material and its standardization," was discussed for 35 minutes with contributions from Professors Nims of Newark College of Engineering, Ewing of Purdue, Dreese of Ohio State, Bennett of Wisconsin, Bauer, Naeter, Coover of Iowa State, Loew of Washington, Caldwell of Ohio State, Jansky of Wisconsin, Pender, and Bibber of Ohio State. Concensus of opinion was against too much standardization either of material or symbols; combined presentation of D.C. and A.C. was favored; the belief was evident that what was needed is more unification and integration of subject matter than standardization.

The second general topic, "A curriculum to train graduates for independent work," was discussed for 30 minutes by Professors Naeter, Ewing, Dreese, Dow of Michigan, Bryant of Minnesota, Paine of Illinois, Fishman of Newark, Bennett, Caldwell, Bauer, Nims, and Brown of Oglethorpe. It was developed that no particular curriculum could train for independent work; the right student with the right attitude and sympathetic instruction could do much; honors plans and electrical shows were mentioned as aiding in developing ability for independent work; example of instructing staff mentioned as important factor.

The first conference was concluded by a 12-minute explanation by Mr. Kubiak of Wisconsin of the special laboratory equipment developed and used at Wisconsin for presentation of electrodynamic phenomena. At 4:15 the first session adjourned for inspection of the exhibit described by Mr. Kubiak.

The Electrical Engineering Division as one of the co-sponsors of the Engineering Economy Conference had many of its members present at the joint meeting on Engineering Economy Tuesday night at 7:30.

Wednesday, June 24.—The first paper, "Importance of Stressing Use of M. K. S. System of Units in Electrical Engineering and

Physics," was presented by Professor Bennett in a 20-minute address. A written discussion of the question by Professor Kennelly of Harvard was read by Professor Bennett.

Discussion of this subject was presented by Professors Dow, Nims, Bibber, and Professor Bennett closed the discussion. It was the sentiment of the meeting that this subject was of such importance not alone to electrical engineering but to physics, mechanics and other major engineering branches that action should be taken to clarify the situation with regard to this system and its use.

It was moved and voted that the Council or Executive Committee of the S. P. E. E. be requested to set up a committee representing the several divisions of engineering education to which such a system of units might be applied; this committee to study the M. K. S. system, its value, place and possibilities of uniform adoption. The committee to report later its recommendations for possible adoption and use. It was the sense of the meeting that Professor Bennett of Wisconsin should by all means be named a member of such a committee when set up.

It was moved that the Electrical Engineering Division express to Professor Kennelly of Harvard regret that his illness prevented his attendance at the meeting.

The first general discussion topic, "Place and importance of design courses in the curriculum," was discussed for 40 minutes by Professors Savant of Georgia School of Technology, Lanier of Missouri, Cory of Michigan State, Nims, Caldwell, Fishman, Bibber, and Mr. Young of Taylor Instrument Company. The general result of the discussion was to indicate that separate design courses had little place in regular curriculum but design ideas might be incorporated with laboratory work, with transformer studies, and that proper presentation of fundamentals would supply material for later elaboration when design was undertaken in industry. Mr. Young defended the continuance of design courses in college.

The second subject, "Means of developing ingenuity of students," brought forth a 10-minute discussion by Professor Mueller of Purdue, Paine, and Lanier. Special problem assignments together with electrical show activities were mentioned as possible agencies.

The third subject, "Engineering seminars in electrical engineering," produced a short discussion by Professors Naeter, Dreese, Bibber, and Paine. From these discussions and from questions asked these by others it appeared that seminar work was increasingly being adopted in a variety of electrical courses; starting at graduate level they are continually being introduced earlier in the curriculum even in junior year. Special value obtained in treat-

ment of subjects not usually presented in regular classwork; directed study with a syllabus found of value; laboratory work parallel with and supplementary to the seminars found of aid.

The fourth and final topic, "Electrical Engineering Summer School," was briefly discussed by Professors Bibber, Coover, and Dreese. It was believed that a separate Summer School of several days was not desirable just now; that the Division Conference might serve the general purpose quite as well if definite program were devised; and that something like the Drawing Conference of this year as a prelude to the general meeting might be a good solution. It was moved and voted that the Executive Committee of the Division look into the possibility and advisability of trying a pre-convention conference similar to the Drawing Conference of 1936.

The final activity of the second conference was a short business session of the Division.

The following officers were elected for 1936–37:

Chairman, Albrecht Naeter of Oklahoma A. and M. College.
Vice-Chairman, George V. Mueller of Purdue.
Secretary, Albert A. Nims of Newark College of Engineering.

Moved and voted that the retiring Chairman each year should be a member ex officio of the Executive Committee of the Division until the next Chairman's retirement.

The suggestion that the Chairman of the Educational Committee of the A. I. E. E. each year should be a member of the Division Executive Committee was favorably received.

It was voted that the Executive Committee of S. P. E. E. be requested to endeavor to secure such an arrangement with the A. I. E. E. as will prevent the recurrence of over-lapping summer conventions.

The attendance on the first day conference was 90; on the second day, 60. Professor Glenn Koehler of the Wisconsin staff acted as Secretary of the Division and contributed much to the success of the conferences by attention to details of room and other arrangements.

On Wednesday night the Division dinner was attended by 101, no business matters or speeches were included in the dinner program.

Considering the A. I. E. E. Pasadena Convention at the same time the Madison attendance was gratifying and the conferences are believed to have contributed much of value to those in attendance. It is expected that the conference of next year may be measurably better due to the experience of the 1936 meeting.

W. S. Rodman, *Chairman*

ENGINEERING ECONOMY

The conference on Engineering Economy was held on June 23, with an attendance of about 180. So many persons expressed a desire to attend both this conference and the one on Manufacturing Processes, which was scheduled at the same time, that it was decided to combine the two conferences, all papers being limited to ten minutes. While this was perhaps the best solution that was possible, it was not at all satisfactory.

This report covers only that part of the conference devoted specifically to engineering economy. The following papers were presented:

Engineering Economy—Independent or Integrated? H. A. Frommelt, Marquette University.

Teaching Engineering Economy in Shop Laboratory Courses. F. H. Thomas, University of Illinois.

Practicable Objectives in Teaching Engineering Economy. E. L. Grant, Stanford University.

Professor Frommelt argued that it was not only unnecessary but even undesirable to offer a separate course in engineering economy. In the following final paragraph of his paper, Professor Frommelt expresses clearly, though briefly, his objections to the separate course.

> In resume, engineering economy would seem to be fundamental to the very concept of engineering activities, and therefore engineering studies. It would seem to follow immediately then that it should be included as part and parcel of every course and branch of the curriculum, and it will not suffice to narrow this concept to profit, within the meaning of that term, as commonly interpreted by the individual organization or enterprise. The engineering educator must insist that included in the term economy is social welfare. The engineer has been accused, and only too frequently justifiably, with a disregard of the social implications of his profession. Narrowing the concept of engineering economy to mere profit-making by an individual concern or enterprise would only serve to clinch this condemnation of the profession.

Professor Thomas discussed briefly the methods used in instructing students in the shop laboratories of the University of Illinois and showed that it was possible to make the students "cost-conscious" in these courses, and "thus [they] receive more benefit from the course than the development of some small amount of manual skill." To effect the desired purpose, various operations are performed on different machines and with different operating conditions. Time studies are made and the student estimates the cost of producing a given number of the article by each method;

the study including the cost of material, scrapped parts, set-up time, idle time, depreciation, labor, power, heat, light, ventilation and management. Possible savings through the use of jigs and fixtures are studied. Production methods are considered in some detail, largely through the use of motion pictures, in order to show modern machines and methods. The economic aspects of materials, including the relationship between cost of raw materials and cost of product, receive consideration.

Professor Grant defined an engineering economy study as an attempt to find the answer to the question "Will it pay?" He also listed the five steps which are likely to be part of an economy study and compared various aspects of instruction in engineering economy to similar aspects of instruction in structural design. Professor Grant showed how the various steps in an economy study parallel those in the structural design problem. He also stated that while engineering colleges cannot turn out thoroughly qualified experts in either structural design or engineering economy, they should expect to turn out men who are qualified to define the elements of problems in these fields. Professor Grant also discussed the question of how instruction in engineering economy should be given and gave his reasons for believing that the best way to teach the fundamentals of engineering economy is in a separate course, which "may well be thought of as bearing a relation to the general problems of making engineering decisions similar to the relation of the courses in the fundamentals of mechanics to the general problems of structural design."

The large attendance at the conference and the lively discussion which followed the formal papers show that engineering teachers are very much interested in this important phase of engineering education. An analysis of the discussion itself shows clearly that not only was there no general agreement as to how engineering economy should be taught, but not even as to what it is. A majority of those taking part in the discussion referred to such social problems as labor relations, business ethics, and the effect on society of increased mechanization. While admitting the great importance of such problems, many advocates of a separate course in engineering economy feel that this particular course may well be limited to instruction in the proper methods to use in making economy studies, or in other words, in answering the question "Will it pay?" It would seem that an ability to determine correctly whether an investment would pay even from a purely financial standpoint should not be a disadvantage when considering the social implications of the various decisions which might be made. As pointed out by Professor Grant, the engineering press

contains many examples of confused reasoning in writings dealing with specific problems of economy. It is not difficult to prove that there is a real loss to society when a decision is based on an incorrect answer to the question "Will it pay?"

This was the third joint conference on the subject, the previous ones having been held in connection with the 1934 and 1935 annual meetings. The 1936 conference was sponsored by the divisions of Civil Engineering, Electrical Engineering and Coöperative Engineering Education, and by the committees on Chemical Engineering, Industrial Engineering, Mechanical Engineering and Mining and Metallurgy. The 1934, 1935 and 1936 conferences were handled by informal committees composed of representatives of the groups which sponsored each conference, but a regular committee has now been authorized by Council with instructions to study this subject and to hold similar conferences in the future, if it seems desirable to do so.

PAUL T. NORTON, JR., *Chairman*

ENGLISH

Three sessions on English were held on June 23 and 24. The first session was devoted to the cultural interests of students and to the methods by which departments of English contribute to such interests. Professor Karl O. Thompson, in a paper entitled "Building Cultural Interests," reported on the attitude of students toward their work in literature at the Case School of Applied Science as indicated by answers to a questionnaire sent to graduates of recent years. The response to the questionnaire was cordial and showed that, for a large proportion of the students, the teaching of literature had had a lasting effect. Professor T. P. Harrison of North Carolina State College read an inspiring paper on "Literature for Students in Engineering." He emphasized particularly the special opportunities and responsibilities of teachers of English in engineering colleges in relation to "the spiritual development of the engineering student." And finally, W. R. Dumble of the Ohio State University discussed "A Suggested Reading List for Junior Engineers." Emphasizing that the primary aim of his list would be genuine enjoyment on the part of the reader, he had a number of concrete suggestions about types of books. He proposed that the list be presented to students at the close of their freshman year, and raised the question as to whether or not they should be required to read a certain number of books during the summer. The papers of this session indicated that departments are making a sincere effort to stimulate reading

habits rather than to teach facts about literary history or about literary masterpieces.

The second session was devoted to writing problems. Professor H. L. Solberg of Purdue University reported on "The Policy and Procedure of the Committee on Standards in English at Purdue University." He indicated details of a system which enables a special committee to check the writing of students who have passed the required courses in composition and to give instruction as found necessary. Professor Lange of Iowa State College discussed a similar plan in effect at his institution, where the work had been extended to students in the graduate school. A paper on "Writing Technical Engineering Compounds," prepared by Professor C. M. Newman of the Virginia Polytechnic Institute, was read by Professor A. J. M. Smith of Michigan State College. The paper pointed out the lack of uniformity of engineering publications in the printing of such compounds, and suggested that there was an opportunity for research that would be the basis for the establishment of standards. A lively discussion followed the reading of the paper, the general opinion being that the matter must be left largely to the natural tendencies of the language. The third paper of this session was presented by Professor George Summey, Jr., of the A. and M. College of Texas on "Tests in English for Engineering Freshmen." It was a thorough and unsparing analysis of representative "objective" tests now in use in various institutions of the country and showed clearly the need for much additional work on such tests if they are to serve adequately the purposes for which they are intended.

At the final session, a dinner meeting, David Sheldon of the University of Wisconsin gave a brief discussion of the methods of teaching English to students in the College of Engineering of the University. This was followed by a round table discussion led by Miss Sada A. Harbarger of the Ohio State University which proved to be particularly stimulating because of the contributions made by those present who were not engaged in the teaching of English. Three definite actions were taken by the conference: (1) A proposal from Professor J. L. Vaughan of the University of Virginia that a special page in the JOURNAL of the Society be assigned to the Committee on English for its use, which had already received the approval of the Secretary of the Society, was approved, and Professor Vaughan was asked to take charge of the enterprise. (2) The chairman of the Committee on English was authorized to appoint a committee for the purpose of examining the possibilities of giving assistance to Professor Summey in the formulation of a test which would be more suitable for the ordinary college freshman, especially in colleges of engineering,

than the tests already in existence. (3) The following resolution, formulated by a committee consisting of C. W. Park, Sada A. Harbarger, and Robert I. Rees, was approved by the Conference for presentation to the Council of the Society: "Resolved, That in the interest of a closer integration of the engineering curriculum, the Council of the Society for the Promotion of Engineering Education is requested to authorize an investigation of the objectives of English instruction in engineering colleges and of the training of English teachers of technical students; and that the President of the Society appoint a committee consisting of technical as well as English teachers to conduct this investigation."

H. L. CREEK, *Chairman*

INDUSTRIAL ENGINEERING

The conference on Industrial Engineering was held on June 24, with an attendance of 15. The following papers were presented:

Industrial Application of Quantitative Industrial Engineering Courses. Paul N. Lehoczky, Ohio State University.

Methods of Instruction in Management at Purdue University. G. H. Shepard, Purdue University.

Effective Teaching of Management Subjects. Hugo Diemer, LaSalle Extension University.

Professor Lehoczky's paper described an unusual elective course offered by their Industrial Engineering Department. This course is known as Production Control Research, and the purpose is to give the student an opportunity to apply quantitative theory to actual plant conditions. The student is given a list of manufacturing plants and is told to go out and convince some industrial manager that his company will profit from the studies which would be made. The student works from 6 to 10 hours per week for one quarter, first surveying the plant and formulating the various problems he sees and then devoting the remainder of his time to a solution of one or more problems. The type of problem varies greatly. In one case the student set up a standard cost and standard time system for a small combination machine shop and foundry, the work involving equipment evalution, time study and job analysis. In another case, an analysis was made of the sales curve of a highly seasonal demand plant. In a third case, the student was asked to replan a division of the plant so that the overall production time could be reduced. The plant management has full control over the student and in-

curs no obligation whatever. The student receives no compensation for his services, although in several cases a student has later been offered a permanent place in the organization.

In his paper, Professor Shepard discussed methods of instruction in management used at Purdue University. He stated that their teaching of management has two immediate objectives; first, indoctrination of the student in the principles of management, and second, practice in the application of the principles. In the industrial engineering option at Purdue the student takes, in addition to the fundamentals of mechanical engineering, a series of courses in the field of management, including principles of management, general accounting, cost accounting, personal administration, industrial design, motion and time studies. In general these courses may be elected by students in other curricula. Professor Shepard stated also that they urge the student to apply the principles of management to his personal affairs and to seek management experience in extra curricular activities and summer work in industry. Professor Shepard also commented on the work being done at Purdue by Dr. Lillian M. Gilbreth as non-resident Professor of Management.

Before presenting his paper, Colonel Diemer discussed the introduction of courses and curricula in industrial engineering into engineering colleges. (It is probably not necessary to mention the rather well-known fact that Colonel Diemer was a pioneer in this work.) Colonel Diemer, who is Vice-President in charge of Education of the Society for the Advancement of Management, discussed a study now being made by that society to determine: first, Where is management taught; second, What is taught; third, How is it taught? He stated that a full report of this 1936 survey would be given at the annual conference of teachers of management to be held in December immediately after the A. S. M. E. meeting, and invited to this conference all those who may be interested. Colonel Diemer stated that there are now 31 institutions offering a distinct curriculum in industrial engineering or industrial management, while 10 other institutions offer organized sequences of industrial engineering or industrial management subjects.

The remainder of the session was devoted to a lively discussion of the papers and other topics of interest to those present. Dean Potter stated that he had tried for a number of years past to make clear to students and faculty that industrial engineering was not merely a part of mechanical engineering, also that at Purdue there was ample opportunity for students in curricula other than mechanical engineering to elect courses in management, but that very few did so. Dean Potter also stated that the main reason

he was present at this conference was to hear this point discussed. Practically everyone had something to say about this particular problem. Apparently the condition mentioned by Dean Potter does not exist to the same extent in colleges where the departmental set-up is such that management courses are not listed as mechanical engineering courses. Professor Dutton (Armour) suggested that these courses might be more generally elected if the primary approach were from a general management viewpoint, with specialized subjects brought in later merely as tools. Professor Shepard suggested that it might be better to use the name management engineering rather than industrial engineering. It was also brought out that student advisers do not always inform their students about management electives and that where advisers do so a larger percentage of students will elect management courses. This seems logical in view of the well-known tendency of engineering students to select their electives in their own specialized fields of study.

The methods used in teaching management courses in their own colleges were described by Professors Bullinger (Penn State), Fuller (Iowa State), Lee (Cornell), Lehoczky (Ohio State), Norton (Virginia Tech), Riggs (Michigan State), and Thuesen (Oklahoma A. & M.).

PAUL T. NORTON, JR., *Chairman*

MACHINE DESIGN

This division of the society held one dinner, one joint, and two afternoon conferences, all of which were well attended. There has been a steady growth in the interest shown in these conferences, which in a large measure is due to the work of Professor F. L. Eidmann, the Chairman of the division, who has devoted a great deal of his time to creating an interest in the Machine Design Clearing House.

Professor E. S. Ault, Case School of Applied Science, was chairman of the first afternoon session, at which papers were presented by J. R. DuPriest, Minnesota; T. Colbert and P. H. Hyland, Wisconsin; and J. V. Martenis, Minnesota.

Professor C. W. Ham, Illinois, presided at the second afternoon conference, papers being presented by P. H. Slaymaker, Nebraska; D. G. Ryan, Illinois, and C. A. Norman, Ohio State. Professor Norman's paper indicated the basic importance of this subject to all engineers whether or not they were ever to make use of it as a designer. Following the presentation of the papers, those attending entered freely into the discussion.

At the dinner meeting F. L. Eidmann, Columbia, discussed the Trends in the Teaching of Machine Design, and Professor Townsend, M. I. T., contributed by many humorous remarks.

A valuable part of this conference was the visit made by about 60 members to design departments and plants of the Gisholt Machine Company and the Madison-Kipp Corporation. The intricate die castings made at the latter plant, together with the making of the dies proved of great interest.

Plans are already under way for another interesting conference at Massachusetts Institute of Technology in 1937.

EDGAR MACNAUGHTON, *Secretary*

PLACE OF MANAGEMENT STUDIES IN ENGINEERING CURRICULA

The general topic of the conference was: "Special Management or Industrial Engineering Curricula vs. Management or Industrial Engineering Courses in Mechanical and Other Curricula."

Professor C. E. Bullinger of Pennsylvania State College presented a paper entitled, "The Place of Management in Engineering Curricula." After a historical review of the origin of the various engineering curricula in mining, mechanical, electrical and chemical engineering as branches of the initial comprehensive curriculum in civil engineering, in response to the growing importance of the corresponding divisions of engineering activities, Professor Bullinger justified the creation of a new independent curriculum in industrial engineering because (1) it satisfies the legitimate demands of outside agencies and (2) no other existing curriculum adequately satisfies these demands.

The development of engineering work led to these new requirements for:

1. The definition of engineering had changed to include the human element.
2. Problems of the coördination of human efforts arose with the development of industry.
3. The study of these problems resulted in a body of principles of management.
4. The ratio of supervisors and administrators to total number of persons gainfully employed is increasing.
5. The ratio of supervisors and administrative leaders to technical experts is four to one.

In Professor Bullinger's opinion a curriculum in industrial engineering should contain the same core of basic courses as that in

other branches of engineering. To these courses should be added four sequences of courses:

1. Methods; dealing with methods of manufacturing; tool, jig and fixture design, time study, etc.
2. Cost Control; dealing with accounting, general and cost; budgeting control, etc.
3. Personnel; dealing with psychology; employment methods; employee training, etc.
4. Organization; dealing with coördination and management.

In closing Professor Bullinger pointed out that the curriculum in industrial engineering is justified because:

1. It meets the modern definition of engineering.
2. It came into being in the same manner as the other major branches of engineering education.
3. Technical societies have been formed to help its development.
4. It is a differentiation and not a specialization.
5. It is an integrated curriculum.
6. It meets a student demand.

Professor John R. DuPriest of the University of Minnesota presented the second paper on "The Place of Industrial Engineering and Management Courses in Engineering Education." Professor DuPriest analyzed the changed requirements and responsibilities which engineering graduates must now meet and pointed out the fact that engineering activities have increased from design and development to include manufacturing, marketing and management. To prepare for this enlarged field engineering colleges have added corresponding courses. These should be considered an expansion of the former mechanical engineering curriculum rather than a new division. Just as radio or highway engineering should properly be considered divisions of electrical and civil, so management should be regarded as a division or broadening of mechanical. And as these new divisions are introduced older courses such as valve gears, boiler design, etc., are being dropped. Professor DuPriest believes that courses in industrial economics, cost analysis, and management should be required for mechanical and available for all other engineering students.

In the discussion following the papers, some new phases of the historical background of industrial engineering were presented. The importance of the unity of purpose carried by the separate curriculum, as compared with options in other curricula, was emphasized. In an electrical engineering curriculum, traditionally, such subjects as machine design and steam power are taught

by the mechanical engineering department. Logically we may expect better teaching of management subjects for civil, electrical and mechanical students if the industrial engineering department is called upon to do the work. The teachers in this department are best able to present to students in other departments in condensed form the most important factors in their subjects.

The president of the British Institution of Electrical Engineers was quoted as favoring college training for those who look forward to administrative positions of responsibility.

Those taking part in the discussion included Hugo Diemer, P. T. Norton, H. P. Dutton, R. L. Sackett, Paul Cloke, O. J. Ferguson and R. S. King.

A strong request was made by those attending the conference that the papers by Professors Bullinger and DuPriest be published in ENGINEERING EDUCATION.

D. B. PRENTICE, *Chairman*

MANUFACTURING PROCESSES

The conference on Manufacturing Processes was held as a joint conference for the Manufacturing Processes, the Mechanical Engineering, the Machine Design, the Engineering Economy, and the Industrial Engineering groups. There were about 125 present.

The theme of this conference concerned methods of giving foundry instruction. Professor Campbell of the University of Michigan presented some of their practices, Mr. Dosey of the Carnegie Institute of Technology gave a paper on foundry instruction for engineering students and Mr. Wendt of Purdue presented methods used at Purdue, including a demonstration of the use of motion pictures.

Mr. Dosey felt that the foundry course should be arranged to survey the entire foundry industry including molding, core making, melting, cleaning, and annealing of castings. He said that every mold the student makes should be cast to arouse student interest. All foundry is given in the freshman year except for students of industrial management. Those taking industrial management at Carnegie Tech took much more foundry than the other engineering students. Mr. Dosey stated that the program of instruction is designed to develop mental alertness and the ability to analyze the problems of industry with a view to promoting efficient management and operation. He also stated that if the graduate engineer has had a training in the fundamentals of foundry practice and has had a general knowledge of the casting of metals, many of the common mistakes made in the processing of articles of commerce can be avoided.

Mr. Wendt said that the chief aim of their foundry course is to teach the fundamental principles in the making of castings. An outline of the lectures of the course was presented by Mr. Wendt. Professor Shepard of Purdue stated that he used the foundry for the work in time and motion study. Mr. Wendt demonstrated the use of moving pictures. The picture illustrated the flow of metal into a mold through an animated cross-section of a mold and also illustrated some foundry operations in their own foundry. The picture, he stated, formed the basis for class discussion.

Professor Daasch of Iowa State College discussed the papers, emphasizing the relation of shop courses to the scientific, design, and management courses. Professor Daasch stated that shop courses should come after fundamental sciences, and hence later in the curriculum than the freshman year. He stated that pictures should not show something in the laboratory as the Purdue picture did, but should bring in material not in the laboratory. It was his observation also, that courses should be broken down into elements and that they should be taught from that viewpoint.

Mr. Kennedy of the American Foundrymen's Association stated that the short time available for foundry makes a careful selection of material necessary. The objective should be to show what is the position and importance of the casting industry. The design of castings and forgings is important. Important factors relative to design should be brought out.

Professor Dorrans of the University of Wisconsin closed the discussion with the statement that there was great discussion and dissension at Wisconsin on the subject under discussion. He stated that others seemed to know as little as they do about what is being taught.

The function of the conferences on Manufacturing Processes is to attempt to clarify and improve the thinking on, and the practices of, engineering manufacturing processes laboratories.

R. L. SWEIGERT, *Secretary*

MATHEMATICS

The conferences on mathematics were held June 23 and 24 with Professor R. V. Churchill of the University of Michigan and Professor W. E. Brooke of the University of Minnesota presiding. The meetings were well attended by a group which showed a very good representation from the various colleges of engineering. There were many interesting discussions of the problems of teaching mathematics in engineering colleges, especially following the conferences and during the luncheon. A very interesting program

was arranged by Professor H. W. March of the University of Wisconsin.

The first conference was devoted to the organization of the Division of Mathematics and to the presentation of two papers on applications of mathematics to engineering.

Professor J. H. Weaver of Ohio State University, Chairman of the Section, took charge of the business of organizing a Division of Mathematics in the Society. The by-laws which he proposed and distributed in mimeographed form were unanimously adopted, and the Division was established to take the place of the present Section. Professor H. W. March was asked to take charge of the nominations for the offices of the Division for the coming year, and the election was held at the beginning of the second conference. These officers were unanimously elected: T. C. Fry, the Bell Telephone Laboratories, Chairman; J. H. Weaver, Ohio State University, Secretary; R. S. Burington, Case School of Applied Science, W. C. Brenke, University of Nebraska, and R. V. Churchill as members of the Executive Committee for periods of one, two, and three years, respectively.

Professor Walter Bartky of the University of Chicago presented the first paper on the program on the "Mathematical Theory of the Thermostatic Switch." He set up and solved a system of differential equations for the relation between temperature and deflection of the beam of the thermostat. Then by introducing approximations in an interesting manner he was able to show the characteristic of sudden action of the switch and to study the interval between making and breaking of the contact of the switch.

Professor L. R. Ingersoll of the University of Wisconsin presented an interesting paper, illustrated by slides, on "Postglacial Time Calculations from Recent Geothermal Measurements in the Calumet Copper Mines." A recent series of accurate temperature measurements in the deep Calumet copper mines gave a geothermal curve which was used as a basis for calculating the time since the last glacial age. An analysis of this curve on the basis of the Fourier heat conduction theory indicated that the ice sheet withdrew from this region some 20,000 years ago, and that the Glacial Age was followed by a temperature somewhat higher than the present, which was succeeded in turn by one somewhat lower.

The following papers were presented at the second conference:

Professor D. L. Holl of Iowa State College: "Engineering and Mathematical Aspects of Problems in Elastic Plate Theory." The results of boundary value problems in the static equilibrium of thin isotropic rectangular plates were presented by exact and approximate solution. The exact solutions are reported by the author in *Iowa State College Jrnl. of Science*, Vol. IX, pp. 597–607 (1935)

and abstract No. 235, Vol. XLII, May (1936), *Bulletin Amer. Math. Society*. The solutions by difference methods will appear in the *Journal Applied Mechanics*, Vol. 3, Sept. (1936). Statically indeterminate problems such as a central load on a plate with only two opposite edges clamped are solved by Trefftz's method for weakened boundary conditions. This interesting report was illustrated with slides.

J. A. Newlin, Principal Engineer, U. S. Forest Products Laboratory: "The Rôle of Mathematics in Engineering Research." As an illustration of how mathematics is used in conjunction with tests in research, there was presented a brief account of the history and development of the present methods of calculating horizontal shear in checked beams. The new method is simple and fairly accurate whereas under certain conditions, the old method gave stresses three times as large as actually existed. Mr. Newlin also spoke from experience about the various advantages of a sound mathematical training to the engineer, and about the importance of coöperation of the mathematicians with the engineers.

Professor L. L. Dines, Carnegie Institute of Technology: "Curriculum and Admission Requirements." In this paper, Professor Dines discussed the differences in admission requirements in mathematics at the various engineering schools, and the consequent differences in the first year courses in mathematics. He emphasized the desirability of giving consideration to the relative merits of the different systems in use, in order that mathematics departments may be in a position to advise wisely if there develops a possibility or necessity for change. In particular he raised the following two specific questions:

First, are we justified in assuming that the standard *four* units of high school mathematics will give adequate mastery of algebra and trigonometry to meet the needs of engineering and to form a basis for the calculus?

Second, should our mathematics departments give energetic support to movements to secure admission requirements of four units of mathematics?

An interesting general discussion followed this paper.

T. C. Fry of the Bell Telephone Laboratories: "An Application of the Theory of Probability to Factory Management." The problem of how many automatic machines it is most economical for one man to attend was solved by Dr. Fry. The problem takes account of the loss resulting from an idle machine when the attendant is occupied and to an idle attendant when no machine needs service. The problem was solved under two different assumptions about the time required to service the machines. A

simple chart was demonstrated from which the solutions could be read.

R. V. CHURCHILL, *Secretary*

MECHANICAL ENGINEERING

The Mechanical Engineering group met at 2:00 P.M. Professor Newton C. Ebaugh ably presided as Chairman.

G. B. Karelitz of the Columbia University presented his paper, "Training in Fundamentals of Mechanical Engineering Students." The paper was discussed by M. P. Cleghorn of Iowa State College; J. R. DuPriest of the University of Minnesota; C. Concordia and L. H. Means, General Electric Company. Mr. Concordia was not able to be present but his written discussion was read by Mr. Means.

The second paper, "Graduate Work in Mechanical Engineering," was presented by H. C. Croft of the University of Iowa. Professors Cleghorn, DuPriest, and Karelitz discussed the paper which created a great deal of interest.

Thirty-eight people attended this meeting, but it was believed that the attendance would have been much larger if the Machine Design group had not been holding a session at the same time.

A Conference Dinner was held at 6:00 P.M. Professor Ben G. Elliott of the University of Wisconsin who presided prohibited any serious discussion of any kind. The group was very well entertained by a Madison lawyer who told of the great engineering ability of Paul Bunyon.

Joint meetings were held with the Committee No. 8, "Teaching of Engineering Economy," and with Committee No. 16, "Manufacturing Processes."

CARL H. CASBERG, *Secretary*

ORIENTATION OF FRESHMEN

The Conference on Orientation of Freshmen was a joint conference with the Junior College group. There were 40 in attendance at this session which turned out to be a very interesting and worthwhile conference.

Dean Sackett of Pennsylvania State College, J. E. Walters of Purdue, and F. C. Dana of Iowa State College gave the principal papers. H. H. Armsby of the Missouri School of Mines and Professor Kahlenberg of the University of Wisconsin gave the principal discussions in which many others participated. One thing that differentiated this meeting from many others was the fact that all speakers talked spontaneously on their subjects and did not read their papers.

Professor E. R. Wilcox, chairman of the committee on Freshmen Orientation, gave a brief summary of the history of the work of the committee. This was followed by Dean Sackett's paper. Dean Sackett's discussion centered on criteria for predicting student success, and on guidance. He stated that the E. C. P. D. had produced a manual for aiding guidance in high schools. Thirty-six societies of professional engineers aided in the guidance program in coöperation with high schools and local institutions. The purpose was to aid the prospective engineer to know what he is facing without being influenced by the spectacular. Along with this work, the use of predictive tests was studied. Recommendations were made for the use of a battery of tests for providing data for use in prediction.

Mathematics and English tests were given in nine institutions in 1934 and in twelve institutions in 1935. Charts were made, plotting the raw test scores of both tests against the actual work ratings of the students. Mathematics proved to be better than English as a criteria for prediction. English was sub-divided into spelling, vocabulary (general), and usage. The English usage had a greater predictive value than the whole English test, but not as good as mathematics. Descriptive geometry was good for prediction.

Tests are not yet definitely in shape. They are in the process of development, but they are an aid. No visualization test can yet be depended upon. The value of the visualization test in vocational guidance also has to be checked.

Dean Sackett stated that problems of adjustment come in the freshman year and very few come in the sophomore year.

Mr. Armsby of the Missouri School of Mines found little in Dean Sackett's paper with which he was not in agreement. He said that it has been rather definitely proved that no good relationship exists between the pattern of the subjects taken and success in college. The quality or ability of a student lies in how the high school student has studied, not so much in what he has studied. A good man can develop along several lines. Success depends upon ability and interest. The present need, stated Mr. Armsby, is a program of testing to get away from the high school record which is variable. An objective measure of preparation is needed. The interest factor, it was stated, was harder to measure, though the Strong test gives a fairly good indication. A guidance program involves a testing program for native ability, followed by advice with encouragement to enter the engineering profession, or to devote more time to preparation for engineering, or to take something other than engineering. He visualized the engineering college as taking only

those qualified and interested in order to turn out high caliber graduates. This ideal can be realized if all groups concerned, the high school, the college, and the profession, coöperate.

Dean Sackett stated the guidance manual was prepared for local engineering sections. They were provided with an interest test later with the hope the engineers would become interested in it as well as the boys. This work brings engineering closer to education and provides more data for proper guidance. He said they found a fine reaction on the part of the high schools. He stated that professional engineers were needed in the program because those trained in general counseling had an inadequate background. He also stated that the E. C. P. D. were anxious for any aid they can obtain.

Dean La Salle of Louisiana State University discussed their plan of the lower and upper divisions, and the restrictions imposed by this arrangement for the improvement of the engineering college.

Professor Nichols of Fenn College stated he was interested in Mr. Armsby's vision of admittance restrictions. Professor Nichols said their experience with Strong's interest test was that it was more reliable for students, three or four years out of high school. It proved more reliable for the night school students whose average age was 22 as compared with day students with an average age of 18. Strong considered his test unreliable for ages under 19.

Dr. Mann stated that Strong's test measured the interest at a particular time. There is much work to be done on the interest test. He stated that more refined tests can be made, for instance to differentiate between mechanical and civil engineering.

Mr. Nichols asked Dr. Mann if he would use the test if 70 per cent effective. His reply was that he would by all means as it gives added useful data.

Dean Sackett stated that best evidence of success was obtainable by the end of the first term. The correlation between grades at the end of the first term with those at the end of the second term and with those for the whole four years is quite high.

Professor Wilcox stated that considerable remedial work can be done for the freshman during the first semester.

Mr. Walters stated in his paper that the student had to be approached from the viewpoint of emotions as well as mind. Many students can do good work if they recognize their possibilities. Thus a counseling program is essential. The system of using senior counselors at Purdue was described and discussed. The counselors were selected and trained for the program. They dealt with the student as a feeling individual as well as a thinking individual.

Professor Dana talked on student reactions, calling attention to points of improvement. The weak spot in the freshman chemistry was the use of graduate assistant's teaching. The graduate assistant is too much tied up in his own problems. He stated that the emphasis was wrongly on research rather than teaching. Most of the orientation in chemistry is negative orientation, which is resentment on the part of the student. He said that some things come down to us by tradition, and that we must examine entire structure from course content on.

Professor Kahlenberg in his discussion agreed with Professor Dana. He talked against the coddling of the student. He stated that quite often the student was hit over the head with the atomic theory the first day, and he never recovered. He stated that no subject can do more to help the freshman, if given right, and none can do more harm. He said that everything depended upon the teacher. Professor Kahlenberg gave much pertinent educational philosophy in his closing discussion.

R. L. SWEIGERT, *Secretary*

PHYSICS

The first meeting of the Physics Conference was called to order by the Chairman, D. S. Elliott, at 2:00 P.M., Wednesday afternoon, June 24. The first speaker, Leonard R. Ingersoll, discussed at some length the Wisconsin Physics Museum begun by the late Professor B. W. Snow. This has been enlarged and developed until it now contains some eighty demonstrations.

The Museum is located in one section of the Main Hall of the Physics building and is open 5 hours per day unattended. The average attendance in the museum is about 100 per day. The apparatus is rugged and carries the necessary information as to the point of the experiment and the directions for its use so that any one can work it. Even the inevitable small boy has been allowed access to it and the total repairs and upkeep are surprisingly low. The Museum is used as part of the regular class work, some assignments requiring the student to visit and become acquainted with one or another piece of apparatus. The discussion brought out the costs, types of exhibit and other items and showed the general interest in the subject.

The second speaker was Claude J. Lapp of the State University of Iowa. He discussed at length the need for new methods of testing students, the use of Objective tests and their findings. The discussion following his paper was quite lengthy as many were very much interested in the whole subject. While agreeing with

his main points many felt that other tests, some at least of the essay type, were essential, to secure a proper picture of the man's training. Professor Woodrow, of Iowa State College, said that in his experience the correlation between achievement in these tests and later achievement in some engineering subjects was lower than the correlation between the old style essay and problem type examination and subsequent achievement. Many others joined the discussion and the subject appeared to be a very important one.

D. S. Elliott of Tulane University discussed the place of Modern Physics in the Engineering Curriculum. He pointed out the need for more of this type of study and suggested various ways of handling it, as to place in the schedule, use of lectures or demonstrations, correlation of work given in physics with that given by other departments, and the relative importance of theory, mathematical treatment, and experimental approach. Here again the discussion indicated that many felt the need for a further study of the whole question of the contents of the course in modern physics and its place in the engineering schedule.

The last paper of the afternoon session was a presentation of two of the University of Chicago Physics Talking Pictures. Before the pictures were shown Donald F. Bean of the U. of C. made some introductory and explanatory remarks. The films were excellent and would be valuable assets in the teaching of the topics covered.

Following the meeting Professors Ingersoll and Wahlin and others of the Wisconsin Physics staff showed those interested the research laboratories.

The dinner session of the Physics Conference was held Wednesday evening. Some 21 were present. The principal speaker was C. G. Watson of South Dakota School of Mines. As one intimately connected with the stratosphere flights he was in a position to give some very interesting details of the flights. After his talk, questions and discussions showed that except for other engagements the meeting would have lasted almost indefinitely.

The second Conference was held Thursday at 9:30 A.M. In the absence of Max H. Peterson of Lehigh, R. A. Sawyer of Michigan presented Mr. Peterson's paper on the Undergraduate Curriculum for Training the Physicist-Engineer. Discussion was postponed until H. L. Dodge of the University of Oklahoma presented his paper entitled, "Twelve Years' Experience in Training the Engineering-Physicist." The gist of both papers was the proper arrangement of courses and schedule to require or at least allow students to take more physics than the single course in general physics. This discussion continued that begun when Pro-

fessor Elliott presented his paper on Modern Physics the afternoon before.

Due to the absence of C. B. Aiken of Purdue University, H. B. Wahlin of Wisconsin read the paper on the "Rôle of Physics in a Graduate Engineering Program." D. L. Ulrey of Westinghouse E. and M. Co. then presented his paper on "The Physicist Engineer in Research and Industry." The need of training in basic fundamentals was pointed out, as well as the other qualifications needed by a young man entering this field. The discussion indicated the feeling of many that physics means very little to the public because so many of its practical applications go by other names. As a result the public in general and the students coming to college in particular are apt to consider specialized engineering courses as the more important, and neglect the basic physical courses upon which much of the rest depends.

E. B. Roberts, of Westinghouse, spoke to the point of high character and broad preparation as essential for success in the engineering field. He listed the following characteristics: intellectual honesty, involving honesty of thinking and honesty in imparting findings; curiosity, diligence, industry, ingenuity, common sense and a willingness to work hard.

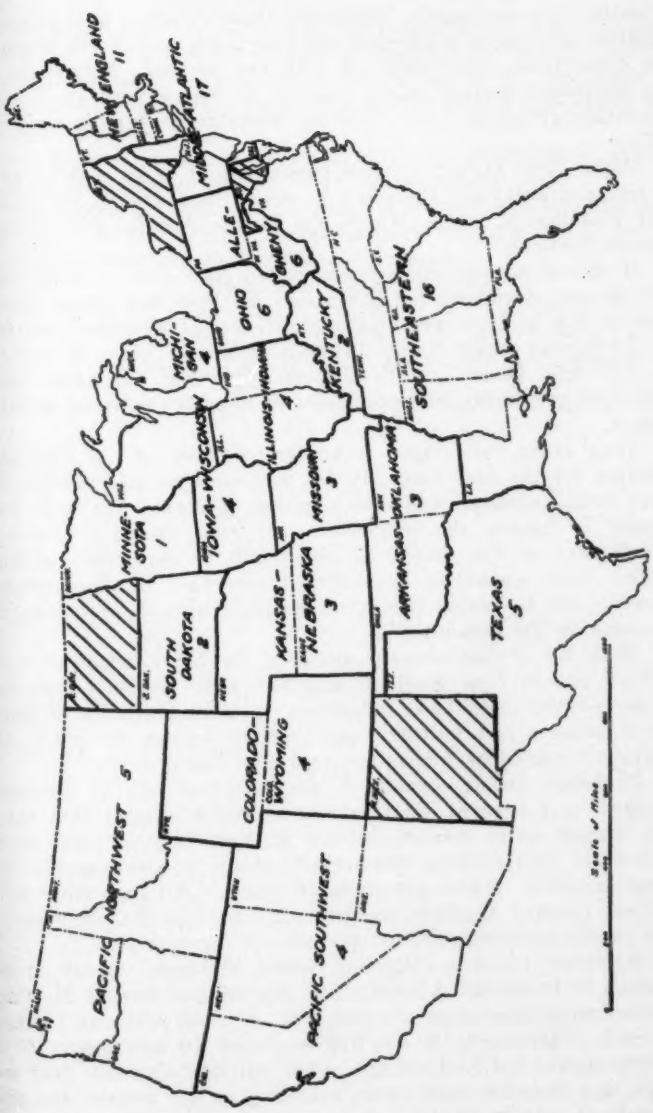
Following the discussion of the papers, this motion was presented and passed: Be it Resolved that the Physics Conference at the Madison Meeting of the S. P. E. E. express to Professors Ingersoll and Wahlin and the department of Physics of the University of Wisconsin the sincere appreciation of the entire conference membership for the gracious and informing hospitality which has made our sessions so enjoyable, and be it further resolved that a copy of this resolution be mailed to Professors Ingersoll and Wahlin by the Secretary of the Physics Conference.

F. L. Brown, *Secretary*

SECTIONS AND BRANCHES

Your Committee which has remained intact during the past two years, has witnessed a steady growth in numbers of sections and branches and of interest in their activities. Recent additions to the list include the Allegheny Section, comprising central and western Pennsylvania, and West Virginia; the Illinois-Indiana Section, the Iowa-Wisconsin Section, and the Southeastern Section comprising a vast territory reaching from the nation's capitol to the boundaries of the Lone Star State. The next in line seems to be the Michigan Section now knocking at our door.

This leaves a very few parts of our country unorganized as far


NEW ENGLAND
11
MIDDLE ATLANTIC
17
ALLE-
GHENY
6
OHIO
6
MICHI-
GAN
4
ILLINOIS-INDIANA
4
KENTUCKY
2
SOUTHEASTERN
16
MINNE-
SOTA
1
IOWA-WISCONSIN
4
MISSOURI
3
ARKANSAS-OKLAHOMA
3
TEXAS
5
SOUTH
DAKOTA
2
KANSAS-
NEBRASKA
3
COLORADO-
WYOMING
4
NORTHWEST
5
PACIFIC
PACIFIC SOUTHWEST
4
Scale of miles

as sections are concerned. The South Dakota Section is at present inactive, although still listed in our year book, and North Dakota has never really been affiliated with any section. Minnesota, a one university section, might well go in, either with the Iowa-Wisconsin group, or take in the two Dakotas, forming a compact unit.

Upper New York State still seems content to be without any section activities; and there is a no man's land around Baltimore and Washington, lying between the Middle Atlantic and Southeastern Sections.

If officers of adjacent sections would take note of these conditions and extend cordial invitations to these unaffiliated members to join in their meetings, a great deal of increased interest in our Society would result. Thus New Mexico might be invited to join with Texas or with Colorado-Wyoming. In these matters, both geography and community of interest are bound to play a part.

Your committee staged a conference here at the Madison Meeting for the first time. It was well received and resulted in some good discussion and dissemination of ideas. We were fortunate in having the inspiration of Dean Seaton's presence, which gave us the benefit of his wealth of experience in this work. Your committee has suffered somewhat in discontinuity of effort due to having few or no members with any previous experience on the Committee.

Dean Ell of Northeastern discussed the News Letter Idea, as carried out in New England and also that Section's activities in coöperation with local industries, in making studies of benefit to colleges and industry and possibly leading to better employment conditions for college graduates there.

Professor Irland explained the workings of the Bucknell Branch, and brought forth comments which showed that there are several active groups, notably at Northeastern, Ohio State, Wisconsin, and Arizona which might easily be encouraged to become branches. There are probably others. We apparently have several inactive branches, as shown by the fact that only six of the twelve branches reported meetings in the past year.

Professor Lovett's (Missouri School of Mines) report on extension of Divisional Activities into Section and Branch Meetings caused much discussion pro and con. If there was any common ground of agreement, it was that small section meetings of 50 or under should not be formally broken up into divisions, that sections and branches must retain autonomy in this respect, and that divisional activities, where desired, should be only a part of the program.

Subsidizing of the Sections by the parent society was advocated by a few, and a notable suggestion was that the Society pay the expenses of some national officer who would be in attendance at Section Meetings, which attendance, by the way, is universally felt to be desirable.

It is your committee's opinion that such a conference as this one might profitably be held every two or three years.

Appended is a map showing how our country is covered by Sections of this Society, the number of institutional members served by each section, and the unaffiliated territories.

Respectfully submitted,

F. M. DAWSON, E. H. FLATH, L. L. VAUGHAN,
R. L. FLANDERS, J. R. MORGAN, D. M. WILSON,
C. G. THATCHER, *Chairman*

CAN SOMETHING OF ENGINEERING EDUCATION BE LEARNED FROM THE EXAMPLE OF JAMES WATT?

By JOHN R. CONNELLY

Assistant Professor of Mechanical Engineering, Lehigh University

The educative process of James Watt was a success, of that there is no doubt. Born into a small merchant's family he retired one of the foremost engineers of his time an honored member of many scientific and learned societies.

The legal attack on Watt's original patent served an unforeseen useful purpose in that it brought forth from Watt a rather complete statement of his intellectual development leading to his first great contribution, the idea of the separate condenser. From this standpoint it is to be regretted that all of Watt's patents were not similarly attacked. In addition Watt's case is an excellent example for study because it is not complicated by any great amount of formal schooling and none beyond the elementary level. Even his trade as a mathematical instrument maker was learned outside the bonds of apprenticeship.

What was the educative process of James Watt? In Watt's own words, "In the winter of 1763–4, having occasion to repair a model of Newcomen's engine belonging to the Natural Philosophy class of the University of Glasgow, my mind was again directed to it (the steam engine). At that period my knowledge was derived principally from Desaguliers, and partly from Belidor. I set about repairing it as a mere mechanician and when that was done, and it was set to work, I was surprised to find that its boiler could not supply it with steam, though apparently quite large enough (the cylinder of the model being two inches in diameter, and six inches stroke, and the boiler about nine inches diameter). By blowing the fire it was made to take a few strokes, but required an enormous quantity of injection water, though it was very lightly loaded by the column of water in the pump. It soon occurred that this was caused by the little cylinder exposing a greater surface to condense the steam than the cylinders of larger engines did in proportion to their respective contents. It was found that by shortening the column of water in the pump, the boiler could supply the cylinder with steam, and that the engine would work regularly with a moderate quantity of injection. It now appeared

that the cylinder of the model, being of brass, would conduct heat much better than the cast-iron cylinders of larger engines (generally covered on the inside with a stony crust), and that considerable advantage could be gained by making the cylinders of some substance that would receive and give out heat slowly. Of these, wood seemed to be the most likely, provided it should prove sufficiently durable. A small engine was therefore constructed, with a cylinder six inches diameter, and twelve inches stroke, made of wood, soaked in linseed oil, and baked to dryness. With this engine many experiments were made; but it was soon found that the wooden cylinder was not likely to prove durable, and that the steam condensed in filling it still exceeded the proportion of that required for large engines, according to the statements of Desaguliers. It was also found that all attempts to produce a better exhaustion by throwing in more injection, caused a disproportionate waste of steam. On reflection, the cause of this seemed to be the boiling of water in vacuo at low heats, a discovery lately made by Dr. Cullen and some other philosophers (below 100, as I was then informed), and consequently, at greater heats, the water in the cylinder would produce a steam which would, in part, resist the pressure of the atmosphere.

"By experiments which I then tried upon the heats at which water boils under several pressures greater than that of the atmosphere, it appeared that when the heats proceeded in an arithmetical the elasticities proceeded in some geometrical ratio; and by laying down a curve from my data, I ascertained the particular one near enough for my purpose. It also appeared, that any approach to a vacuum could only be obtained by throwing in large quantities of injection, which would cool the cylinder so much as to require quantities of steam to heat it again, out of proportion to the power gained by the more perfect vacuum; and that the old engineers had acted wisely in contenting themselves with loading the engine with only six or seven pounds on each square inch of the area of the piston. It being evident that there was a great error in Dr. Desaguilers' calculations of Mr. Beighton's experiments on the bulk of steam, a Florence flask, capable of containing about a pound of water, had about one ounce of distilled water put into it; a glass tube was fitted into its mouth, and the joining made tight by lapping that part of the tube with pack-thread, covered with glazier's putty. When the flask was set upright, the tube reached down near to the surface of the water, and in that position the whole was placed in a tin reflecting oven before a fire, until the water was wholly evaporated, which happened in about an hour, and might have done sooner had I not wished the heat not much to exceed that of boiling water. As the air in the flask was heavier

than the steam, the latter ascended to the top and expelled the air through the tube. When the water was all evaporated, the oven and flask were removed from the fire, and a blast of cold air was directed against one side of the flask, to collect the condensed steam in one place. When all was cold, the tube was removed; the flask and its contents were weighed with care; and the flask being made hot, it was dried by blowing into it by bellows, and when weighed again was found to have lost rather more than four grains, estimated at 4½ grains. When the flask was filled with water, it was found to contain about 17⅛ ounces avoirdupois of that fluid, which gave about 1800 for the expansion of water converted into steam of the heat of boiling water.

"A boiler was constructed which showed, by inspection, the quantity of water evaporated in any given time, and thereby ascertained the quantity of steam used in every stroke by the engine, which I found to be several times the full of the cylinder. Astonished at the quantity of water required for the injection, and the great heat it had acquired from the small quantity of water in the form of steam which had been used in filling the cylinder, and thinking I had made some mistake, the following experiment was tried:—A glass tube was bent at right angles; one end was inserted horizontally into the spout of a tea-kettle, and the other part was immersed perpendicularly in well-water contained in a cylindric glass vessel, and steam was made to pass through it until it ceased to be condensed, and the water in the glass vessel was become nearly boiling hot. The water in the glass vessel was then found to have gained an addition of about one-sixth part from the condensed steam. Consequently, water converted into steam can heat about six times its own weight of well water to 212° or till it can condense no more steam. Being struck with this remarkable fact, and not understanding the reason of it, I mentioned it to my friend Dr. Black, who then explained to me his doctrine of latent heat, which he had taught for some time before this period (summer 1764); but having myself been occupied with the pursuits of business, if I had heard of it, I had not attended to it, when I thus stumbled upon one of the material facts by which that beautiful theory is supported.

"On reflecting further, I perceived, that in order to make the best use of steam, it was necessary—first, that the cylinder should be maintained always as hot as the steam which entered it; and secondly, that when the steam was condensed, the water of which it was composed, and the injection itself, should be cooled down to 100° or lower, where that was possible. The means of accomplishing these points did not immediately present themselves; but early in 1765 it occurred to me, that if a communication were opened

between a cylinder containing steam, and another vessel which was exhausted of air and other fluids, the steam, as an elastic fluid, would immediately rush into the empty vessel, and continue so to do until it had established an equilibrium; and if that vessel were kept very cool by an injection, or otherwise, more steam would continue to enter until the whole was condensed."

The process began with (*a*) the realization that a problem existed ("I was surprised to find that its boiler could not supply it with steam, though apparently quite large enough"). The process continued: (*b*) a cut and try search for the difficulty (forcing the boiler and changing the amount of injection water), (*c*) an organized search for the difficulty (experiment to determine "the expansion of water converted into steam of the heat of boiling water," construction of a boiler to indicate the amount of steam drawn off per stroke of the piston and an experiment that determined that, "water converted into steam can heat about six times its own weight of well-water to 212° or till it can condense no more steam"), (*d*) a realization of the true nature of the difficulty ("On reflecting further, I perceived, that in order to make the best use of steam, it was necessary,—first that the cylinder should be maintained always as hot as the steam which entered it; and secondly, that when the steam was condensed, the water of which it was composed, and the injection itself, should be cooled down to 100°, or lower, where that was possible"), (*e*) a proposal to overcome the difficulty ("It occurred to me, that if a communication were opened between a cylinder containing steam, and another vessel which was exhausted of air and other fluids, the steam, as an elastic fluid, would immediately rush into the empty vessel, and continue so to do until it had established an equilibrium; and if that vessel were kept very cool by an injection, or otherwise, more steam would continue to enter until the whole was condensed"), (*f*) construction of a simple model to test the idea, (*g*) success of test and fixation of principle discovered, and (*h*) extension of principle (pump to evacuate the condenser, jacket for the cylinder, etc.). It is to be particularly noted that Watt was not aware of the theory of "latent heat" when he performed the experiment bearing upon it.

Our present process of engineering education begins by setting before the prospective engineer a collection of theories and mathematical expressions with 'examples and exercises' semi-arbitrarily grouped as various sciences. The student is instructed to 'master' this 'material' and (as he learns by experience) be ready to set it back before the instructor undamaged. No particular mental labor is called for and little required. In later courses the student is to 'apply his theory' in the various professional courses. Evidently we have now dispensed with all the earlier laborious stages of

Watt's educative process retaining only the last two. Learning without labor? Understanding without thinking? Possibly the Royal Road to Learning has been discovered! What evidence have we to show that such an education will produce engineers? What engineers we have now among us achieved success years after graduation, indicating the probability that some men will be successful in spite of all handicaps, even a college education. They furnish no such direct evidence for our present system of engineering education as Watt does for his educative process.

In short Watt's intellectual development began with experience and the realization of a problem and ran in the order of random search, organized search, realization of the true nature of the problem and the factors involved, suggested solution, and extension of principle in application. Now formal engineering college education consists of presentation of principles and illustrations and extension of theory in applications.

Early in the history of engineering education the pre-college experience on matters pertaining to engineering of a majority of the students combined with the college work to give a total somewhat approaching the educative process of Watt. During the last few years this pre-college experience has decreased almost to the vanishing point. By not changing in principle the teaching methods of the engineering college the result has been actually to change the educative process of our engineering graduates. The present educative process can by no stretch of the imagination be said to even approximate that of Watt.

This path of Watt, which in the past has led to success, and which engineering education might well follow, will necessitate the following changes in our engineering education:

1. Cease requiring students to memorize a collection of theories grouped semi-arbitrarily as various sciences.
2. Forsake the false god of "material covered" and worship again the aim of student understanding.
3. Realize that learning cannot be regimented and that an engineering teacher must be an educational research worker.
4. Make a definite effort, vicariously at least, to supply a minimum of experience in the basic experiments of engineering.
5. Make engineering education an intellectual problem to the students.

It is suggested that the administrative side of the above can be accomplished by:

1. Devoting the engineering part of the freshman year to a study of the basic experiments in the physical sciences.
2. Devoting the engineering part of the sophomore year to a study of the basic experiments in the division of engineering elected.

3. Placing the present subjects of physics, chemistry and advanced mathematics in the junior year making this the year of integration.

4. Making the senior year the place for extension of principles to special applications in the department elected.

Ultimate success depends on the extent to which members of the faculty subscribe to point 3, namely, that learning cannot be regimented and that an engineering teacher must be an educational research worker.

Until a better way can be proved, ought not engineering education to tread the path that in the past has led to success?

PRELIMINARY EVALUATION OF THE EFFECT ON MECHANICS OF A REORGANIZATION OF CALCULUS *

By SAMUEL B. FOLK

Associate Professor of Mechanics, The Ohio State University

In May, 1934, the Department of Electrical Engineering proposed to the Faculty of the College of Engineering, that the Sophomore Electrical Engineers take their Calculus in experimental sections in which the techniques and processes of the subject would be taught in connection with physical phenomena and relationships ordinarily occurring in engineering practice, and best treated by the applications of the Calculus.

The instructor of these sections should be an engineer in training and viewpoint with an excellent grasp of mathematics. The committee supervising the course would consist of representatives of the Departments of Electrical Engineering, Physics, Mathematics and Mechanics. It was suggested that some members of the committee might wish to teach a section.

Subsequently the Department of Mathematics proposed that a committee be appointed to determine the principles and applications of certain mathematics courses, the proper order of presentation from the standpoint of courses in Physics, Chemistry, Mechanics, and the technical courses in engineering, and to make recommendations concerning improvements in teaching.

The Faculty, apparently impressed with these proposals, passed both motions and two committees were appointed—the first to steer the one year Experimental Group in Calculus, and the second to plan for closer coöperation between departments and improve the teaching.

Students were scheduled for Calculus at three different hours in the day. It was found that if only the Electricals were segregated from others at each hour, the sizes of all the classes were unbalanced and the teaching load too large. Therefore the Mechanicals and Civils were combined with the Electricals and placed in one section at each scheduled hour. These three sections were taught by a Professor of Mechanics, a Professor of Electrical Engineering, and Professor of Mathematics. An Instructor with a baccalaureate

* Presented at the Annual Meeting of the Ohio Section, S. P. E. E., at Case School of Applied Science, April 18, 1936.

degree in Chemical Engineering and a doctorate in Mathematics was obtained to correlate the sections, substitute in teaching at certain times, devise practical problems, make up tests, and grade papers. There seemed to be no suitable text from the engineering viewpoint, although one was chosen for these classes. The text used for regular sections was continued as usual. The instructors presumably used their individual teaching methods but held weekly conferences on the progress of the work and plans for its presentation.

It is perhaps too early to tell if the project is a success. But as one who had nothing to do with the experiment, but who has attempted to control the assignments and examinations in portions of the work in Mechanics exactly as they have been controlled for the past several years, I believe it is, safe to say that progress is being made. That progress seems to be sufficient to warrant telling other members of the society about it.

This paper is concerned with an effort to evaluate the results of the experiment by means of the students attainment in Mechanics. Of the 242 students who started Calculus in the autumn of 1934, two groups were formed—the Experimental Group in special sections; the other, the Control Group in regular sections. The following table shows what happened to these students during the Autumn Quarter:

	Four Regular Calculus Sections		Three Special Calculus Sections	
Number starting in Autumn Quarter		133		109
Number dropping out of class 1st Qtr.	7		17	
Number failing in 1st Qtr.	10		15	
Number finishing with passing grades		116		77
Number not registered in engineering		54		
Number completing Calculus and starting Mechanics		60		62

From these two groups, there were selected two groups of 58 because the average of their College Intelligence Tests were nearly equal. These were:

	Control Group	Experimental Group
Percentile	81.94	81.41

This Intelligence Test (known as the Ohio State University Psychological Test) is taken by the Freshmen when entering the university unless he has previously taken it as a High School Senior. About one-third, and sometimes nearly as many as one-half have taken it in high school, where it is given annually to 50,000 to 60,000 of the 150,000 seniors in Ohio.

The Point-hour Ratio for these 116 men at the end of their Freshman year was obtained and averaged for each group:

	Control Group	Experimental Group
Point-hour Ratio	2.86	2.74

This is based upon the grades and hours received, using A (excellent) = 4 points, B (good) = 3, C (average) = 2, D (poor) = 1, and E (failed) = 0. There is no Condition mark. To graduate requires an average of 1.8. Figure 1 shows graphically the distribution of the 242 students entering, first quarter Sophomore Calculus, the Intelligence Test average and the Point-hour Ratio average for the two selected groups. They were fairly equal with the Control having a slight edge in Freshman Intelligence Score and a larger margin in Point-hour Ratio to start the Sophomore year.

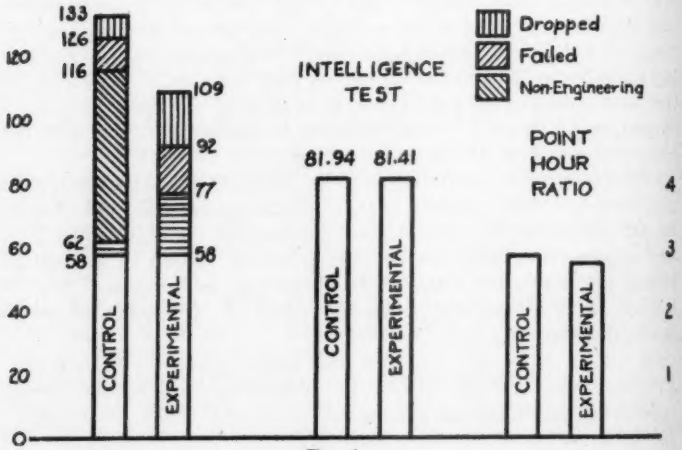


FIG. 1.

Due to scheduling difficulties all the students could not be kept in the same sections again in the Winter and Spring Quarters. It was felt that if a student had two quarters in either an Experimental or a Control section, and followed this with at least one quarter of Mechanics, he should be considered in this study. In Fig. 2 is shown the distribution of grades in the three quarters of Calculus (the course numbers being 441, 442 and 443), the left bar being the Control Section and the right bar the Experimental in each case. The diagonal hatching indicates the per cent failing and the vertical represents those dropping out. It should be made clear that

there could be none in the groups chosen who failed in the first quarter, although a student could have passed the first quarter and failed the second and still be considered: [He has been in the group two quarters, and he could have repeated the failed course in the spring, completed his Calculus in the following autumn and arrived in Mechanics in time to be included in this survey]. Furthermore, a few of the curricula require only two quarters of Calculus. The numbers at the bottom of the vertical bars indicate the number of the 58 students who were in these sections each time.

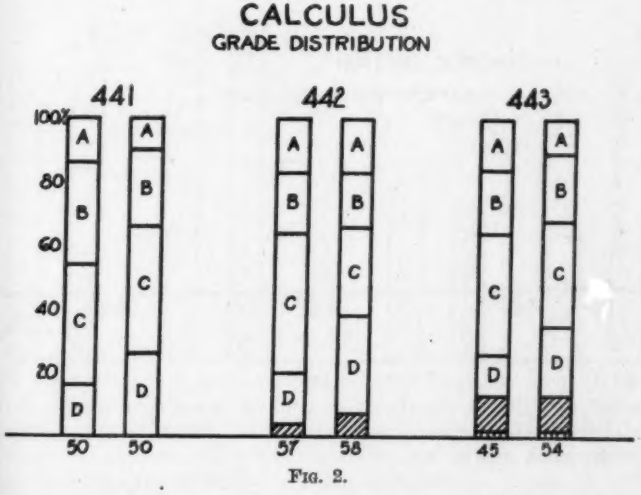


FIG. 2.

Figure 3 shows the Point-hour Ratio for these groups in Calculus. They are figured omitting the students who dropped out:

	Control	Experimental
Number of students starting 441	50	50
Number of students finishing	50	50
Point-hour ratio	2.44	2.18
Number of students starting 442	57	58
Number of students finishing	57	58
Point-hour ratio	2.31	2.07
Number of students starting 443	45	54
Number of students finishing	44	53
Point-hour ratio	2.16	1.98

The electrical, ceramic and mining engineers take their Statics (the first quarter of their Mechanics) in the spring of the Sopho-

more year. The electricals take the third quarter of Calculus concurrently. All carry five hours of Physics at the same time. All other students take Statics in the autumn of their Junior year. These two courses in Statics are essentially the same. The course is again repeated in the winter for the benefit of irregulars. At least 14 of these men took it at that time, 11 of whom either had

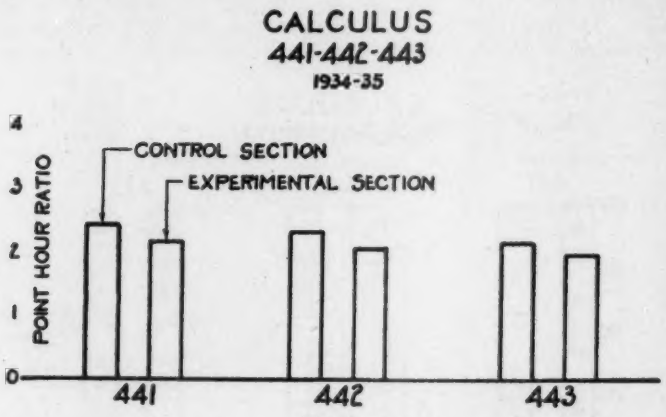


FIG. 3.

failed to pass the first time or had so much difficulty that they dropped out. They are therefore counted more than once and the total taking Mechanics is more than 58. The number who had difficulty with Statics is:

	Control	Experimental
Failed	5	3
Dropped out	9	4

There was no effort in Mechanics to section the men according to their previous Calculus training. They registered in the regular sections so that generally their instructor did not know their background. The sections were taught by the regular staff of the department with one exception. In order to compensate for time of the Professor of Mechanics who taught Calculus, one man from Mathematics taught a section of Statics each quarter. This exchange arrangement, assuming that the instructors are competent, is a valuable by-product of the experiment. Nothing contributes as much to the other fellow's viewpoint as trying to do his work better than he is able to do it. The progress of all sections in Statics was fixed by mimeographed assignment sheets made up by an instructor who has been teaching the work for the past six years.

This instructor makes up all tests and final examinations; although each one grades his own papers, it is thought that the system is well standardized so that there is little variation in the grading. In cases of doubtful failing the papers are generally graded by a second instructor as a check. Figure 4 shows the distribution of grades and average point-hour ratio attained in Statics. The left

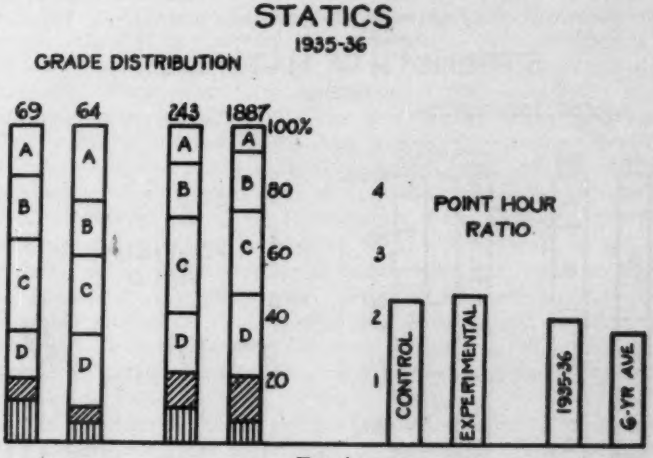


FIG. 4.

bar gives the results of the 69 marks given to those from the Control sections. The next bar gives the 64 marks of the Experimental. The third bar gives the percentage distribution of marks of the entire 243 men who took the course in spring, autumn, of 1935 or winter of 1936. The fourth bar from the left gives the distribution for the 1887 students who took the subject during the six years 1929–35. The diagonal hatching again represents the failed and the vertical the dropped students. The average point-hour ratio for these four groups is represented by the four bars at the right in the same respective order. These Point-hour Ratios are:

	Point-hour Ratio
Control	2.27
Experimental	2.33
All students 1935–36	2.02
Six years 1929–35	1.79

Following Statics all engineers are required to take a five credit-hour course in Strength of Materials, consisting of four recitations and a two-hour laboratory period. The same proceed-

ure with mimeographed assignment sheets and examinations is followed here as in Statics. One instructor has been making up all the tests and examinations for several years, and since he had not coöperated in the teaching of the calculus, he made no attempt to alter the type of question and problem usually asked, in order to test out particular ideas developed during the past year in the Calculus. This point is important because it enables a comparison to be made with the previous records made in the course. Figure 5

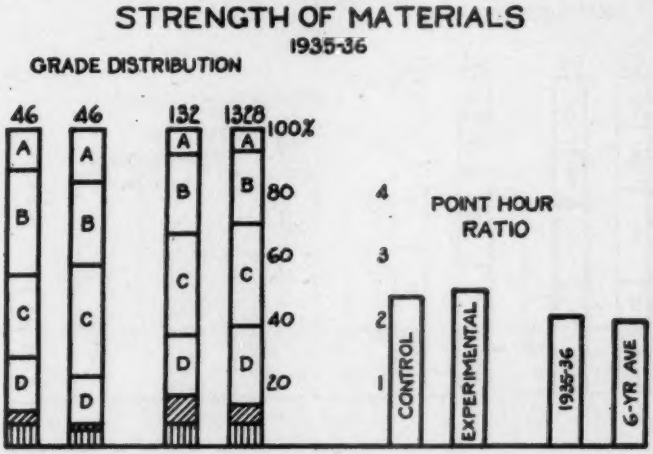


FIG. 5.

shows the distribution of grades in Strength of Materials, the bar at left being for the 46 students from the Control Group in Calculus. The next bar represents the 46 who came from the Experimental Section. The bar labeled 132 is for all students taking the course in the Autumn or Winter Quarters in 1935–36 and includes the 92 in the previous groups. The fourth bar shows the distribution of grades of the 1328 students who took the course in the Autumn and Winter Quarters during the six years 1929–35. The next four bars are the Point-hour Ratios for the same groups respectively. They were:

	Point-hour Ratio
Control	2.35
Experimental	2.43
All students Autumn and Winter 1935–36	2.05
All students Autumn and Winter 1929–35	1.98

The results seem to indicate that the Control Section had a very slight edge on the Experimental in the Intelligence Test and in the Point-hour Ratio at the beginning of the Sophomore year. The

data seem to indicate that the Control Section came through Calculus with somewhat better grades than the Experimental. There were six different instructors who taught the regular sections at different quarters during the year, whereas the same three men taught the special sections all year. Just what methods these nine men used is not known. They might conceivably subscribe to any of the five theories of teaching suggested by Henry Seidel Canby in *Harper's Magazine* (March 1936)* although not all of them seem as applicable to engineering as to literature. The instructors in statistics feel that the students come to them better prepared, than formerly. They seem to progress faster and accomplish more, especially in centers of gravity and moments of inertia by integration (which is covered in the Statics course). A more inspired attitude was noted in Strength of Materials, presumably due to the enthusiasm which carried them along, and due to better correlation of Mathematics with their engineering work. What alterations might be made in the teaching of all Mechanics work is not yet evident. It might be possible to reduce the effort on some topics and emphasize other parts more. No effort has been made to drag in the calculus where it is not needed, and conversely no effort has been made to avoid it where the proof requires it. The student is expected to master these portions of the theory and be able to apply them.

The experiment is still being continued. A Professor of Geodetic Engineering and a Professor of Mechanics are teaching sections of Calculus this year. The Physics Department has joined in and has revised its Sophomore course to parallel the Calculus. Integration is taught early in the first quarter in Calculus and its formulas and methods applied in the Physics about one week later. This enables the student to immediately use his mathematics and clinch its meaning. This was not done last year and its effect will not be noticed in Mechanics until next year. But no comparison can be made next year because all the Calculus is now being handled by the one method. However if the Mechanics can be standardized for another year, the next class may be compared with this and with the six year average. Whether this is advisable is another question. Should Mechanics take advantage of the improved quality of attainment in Physics and Mathematics to (1) cover more ground, (2) raise standards, (3) shift the emphasis, and (4) alter teaching methods? If we do we seem to lose any standard of comparison we now have. If we do not we are not alive to the state of flux in Physics and Calculus, and might do the student an injustice. A discussion on this point would be welcome.

* These five schools are the Hardboiled, Indifferent, Idealistic, Factual, and Enthusiastic.

AMERICAN ENGINEERING COUNCIL

A graphic presentation of the engineering organizations of the United States and their "instrumentalities," sponsored by American Engineering Council, formed a part of the exhibit of the Third World Power Conference. The penetration of the engineer into the arts and industries and the specialization that has taken place in the relation of the engineer to management of industrial and business enterprises of all kinds was strikingly illustrated by the wide variety of national engineering organizations and by the objectives of the functional organizations which are supported by the so-called founder engineering societies.

This exhibit of the number, locations and objectives of the engineering organizations of the United States was prepared by the American Engineering Council in coöperation with the national, state and local engineering societies at the request of the officers of the Third World Power Conference. The exhibit was presented by American Engineering Council's Committee on Publicity for the Engineering Profession as a contribution to further public understanding of the work and purposes of the engineer. The exhibit and a special brochure prepared for distribution to the delegates of the Third World Power Conference, were both presented by the Committee as a contribution to this wider understanding. Both the exhibit and the brochure brought together for the first time into a composite whole a complete picture of the engineering organizations of the United States.

The exhibit itself was unique and interesting. The central feature was a huge map of the United States measuring approximately eight by twelve feet. On this map were spotted the locations of the national engineering societies and their local sections, the state engineering societies and the independent local engineering groups. Grouped around the central feature were panels on which were presented the names and salient features of (1) the four national founder societies, (2) the instrumentalities or functional organizations, which are supported by the founder societies and by other national engineering bodies, (3) a series of lists of names and locations of the national, state and local engineering organizations which responded to the invitation to participate in the Engineers' Exhibition during the Third World Power Conference.

Brief descriptions of the objects and purposes of each of the

functional organizations were presented on their respective panels. These functional organizations are as follows: United Engineering Trustees, Inc., The Engineering Foundation, National Research Council, American Standards Association, Engineers' Council for Professional Development, American Engineering Council, Engineering Societies Employment Service, Engineering Societies' Library. The color scheme of the exhibit was blue, white and gold and the charts and panels were prepared in such way that they can be readily re-assembled for future exhibitions.

The brochure prepared by the American Engineering Council in addition to containing descriptions of each of the functional organizations, lists the name, the secretary, and membership and principal activities of fifty-three national engineering societies, forty state associations and ninety-six local organizations. It contains also a brief article entitled, "Why the Engineer," contributed by Dr. W. F. Durand, Chairman of the Third World Power Conference and the John Fritz Medalist for 1935. Greetings from the Engineers of the United States to the Delegates to the Third World Power Conference are conveyed in the booklet, signed by the members of American Engineering Council's Committee on Publicity for the Engineering Profession. They are as follows: Messrs. Charles E. Stephens, Chairman, Harrison E. Howe, Larry F. Livingston, Watson Davis, Frank McCausland and Charles K. Weston. The printing of the brochure was made possible through the courtesy of the Washington Society of Engineers, Washington, D. C.

The extent of the success of the Third World Power Conference will not be fully known until all of the post conference tours are completed and the delegates express themselves, but it is reported that they elected Dr. W. F. Durand President and Mr. O. C. Merrill Vice President of the World Power Conference which is the permanent organization. Such recognition is merited in many ways but it is also an international mark of appreciation of the unusual personal efforts made by these distinguished engineers to prevent their conference from becoming a sounding board for social theories, and to keep discussions of government ownership vs. private ownership and other controversial subjects on the basis of fact and logic rather than that of theory and desire.

The T-SQUARE PAGE

DEVOTED TO THE INTERESTS OF THE DIVISION OF ENGINEERING DRAWING

FRANK A. HEACOCK, EDITOR

A New Class of Beginners

In our engineering colleges thousands of new students are just beginning an engineering education. Fortunately most of these freshmen make their first contact with engineering through the friendly medium of engineering drawing, getting the best start by learning first of all the language of the engineer.

The beginner in engineering drawing starts the course with interest and enthusiasm fostered by native curiosity, by the fascination of new instruments, and by the discovery of a new vehicle of expression. This interest can be sustained throughout the course and the enthusiasm of the first few weeks can be guided and converted into useful results. How may we best utilize these natural forces for good?

Interest thrives on novelty, variety, and understanding. There is novelty in the third dimension and the elastic view-point, and each new problem has novel features to sustain the interest and diversify the experience of learning. Dimensioning, sections, and pictorial views provide variety in abundance. But in addition to these stimulants a lasting interest demands food for thought. Constructive thinking must keep pace with drafting skill. The beginner must learn *why* as well as *how*. Timely explanations and frequent plan-reading exercises keep the brain active while the pencil is busy. They develop understanding, visualization, and the ability to think in three dimensions. Drawing and sketching provide an outlet for new ideas, a satisfying means for self-expression. So the enthusiasm of the beginner is kept alive and converted into initiative—a resourceful eagerness to read and write the engineering language.

Here is a rich opportunity for the teacher of engineering drawing—a challenge and a responsibility. Will he match the enthusiasm of the beginner with an enduring enthusiasm of his own? Will he profit by past experience and the lessons learned from last year's errors and make this year's course better than ever?

ENGLISH NOTES

DEVOTED TO THE INTERESTS
OF TEACHERS OF ENGLISH
IN ENGINEERING SCHOOLS

J. L. VAUGHAN, EDITOR

THE IMPORTANCE OF READING

The publication in the JOURNAL of this column, "English Notes," is one of the many indications of increasing appreciation of the importance of English in the engineering curriculum. Those who know the writer also know that for a number of years he has ridden a hobby almost to the stage of boredom to his listeners, on the importance of good reading for engineering students and young engineers. As a representative of industry, he knows that employers are now demanding of graduates a good command of English.

There has been a steady improvement in the teaching of English, and yet through all the efforts to develop in engineering students high standards of clearness, correctness, and effectiveness in writing and speaking, it would seem that one of the most important tools has been neglected. In *reading* we have the key to all these—clearness, correctness, and effectiveness. They have been given to us by the writers of great literature, and along with them comes excellence of style, which, by the way, usually consists in simplicity.

Reading is the introduction to the culture of the ages and is almost the only way in which an engineer, busy with his professional development, can become an educated man. Courses in literature are too likely to be elective in an engineering curriculum. I would, therefore, if it is becoming of me, urge upon all faculties of engineering to motivate the student towards a love of good reading. Reading habits developed on the campus and carried on through life, will promote professional competence, and contribute to personal satisfaction and the joy of living.

R. I. REES

NEW MEMBERS

BECKETT, FARLEY E., Engineer, Diesel Dept., National Schools, 4000 So. Figueroa, Los Angeles, Calif. V. L. Maleev, A. J. Drakoff.

DUNCOMBE, CHARLES G., Professor of Chemical Engineering, University of Detroit, Detroit, Mich. C. J. Freund, C. J. Pajot.

ENNIS, WILLIAM D., Alexander Crombie Humphreys, Professor of Economics of Engineering, Stevens Institute of Technology, Hoboken, N. J. H. P. Hammond, Paul T. Norton, Jr.

FEIKER, FREDERICK M., Executive Secretary, American Engineering Council, 744 Jackson Place, Washington, D. C. F. L. Bishop, F. J. Chesterman.

GALLAGHER, GEORGE A., Instructor in Civil Engineering, Los Angeles Junior College, Los Angeles, Calif. C. E. Guse, J. W. Hazen.

HERSHEY, MAYO D., Research Associate in Engineering, Brown University, Providence, R. I. James A. Hall, W. H. Kenerson.

KIMBARK, EDWARD W., Instructor in Electrical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. Carlton E. Tucker, E. L. Moreland.

LESLIE, DANA D., Instructor in Civil Engineering, North Dakota State College, Fargo, N. D. R. M. Dolve, F. L. Plummer.

MCCRUMM, JOHN D., Instructor in Electrical Engineering, Swarthmore College, Swarthmore, Pa. Howard M. Jenkins, George B. Thom.

PEABODY, DEAN, JR., Associate Professor of Structural Design, Massachusetts Institute of Technology, Cambridge, Mass. Arthur L. Townsend, Kenneth C. Reynolds.

PETERSON, ERNEST F., Professor of Electrical Engineering, University of Santa Clara, Santa Clara, Calif. Geo. L. Sullivan, Ed. C. Flynn.

PROTHEROE, THOMAS G., Manager, Employment Service, Cleveland Engineering Society, Cleveland, Ohio. Kenneth W. Reed, E. S. Ault.

ROGEL, ALBERT C., Assistant in Civil Engineering, New York University, New York City. Douglas S. Trowbridge, Lewis V. Carpenter.

STANLEY, WILLIAM E., Consulting Sanitary and Hydraulic Engineer, Greeley & Hansen, 6 No. Michigan Avenue, Chicago, Ill. Re-instatement.

STIMSON, STEPHEN K., Instructor in Engineering Drawing. Ohio State University, Columbus, Ohio. Thos. E. French, F. W. Marquis.

TRIGGER, KENNETH J., Instructor in Mechanical Engineering, Swarthmore College, Swarthmore, Pa. Scott B. Lilly, George B. Thom.

DIVISIONS

The personnel of the Executive Committee of the Electrical Engineering Division is as follows:

A. Naeter, Chairman, Oklahoma A. & M. College.
George V. Mueller, Vice-Chairman, Purdue Univ.
A. A. Nims, Secretary, Newark College of Engr.
O. W. Eschbach, Chairman, A. I. E. E. Committee on Education.
C. E. Tucker, Mass. Institute of Technology.
W. S. Rodman, Univ. of Va., 1936, Chairman and Ex-officio member.

The officers of the **Mathematics Division** for the year 1936–37 are Chairman, T. C. Fry; Secretary, James H. Weaver; Members of the Executive Committee, Richard Burington for one year, W. C. Brenke for two years, and R. V. Churchill for three years.

SECTIONS AND BRANCHES

The **Illinois-Indiana Section** of the Society held its second annual meeting on April 18, 1936, at the Lawson Y. M. C. A., Chicago, Ill., under the auspices of Armour Institute of Technology.

The members and guests were welcomed by Dr. W. E. Hotchkiss, President of Armour. Following the welcome by Dr. Hotchkiss President J. B. Finnegan of Armour introduced the speakers of the morning session.

Professor Hardy Cross of the University of Illinois gave an address entitled "Concerning the Importance of Teaching School."

Mr. Lawrence A. Downs, President of the Illinois Central System, spoke on "Engineering Education as a Preparation for Business Responsibilities."

Dean H. T. Heald of Armour Institute addressed the convention on "Part Time Graduate Education in Chicago."

Following the addresses of the morning session the convention carried out the routine business of the annual meeting, including the election of the following officers for the year 1936–37:

President: R. P. Hoelscher, Illinois.
Vice-President: H. S. Philbrick, Northwestern.
Secretary: S. M. Spears, Armour.

Executive Committee:

Rose Polytechnic Institute, O. L. Stock,
Purdue University, R. N. Shreve,
University of Illinois, M. A. Faucett,
Armour Institute, J. C. Peebles.

After the morning session a luncheon meeting was held at the cafeteria of the Lawson Y. M. C. A. There were brief addresses by the retiring President, President-Elect, and some of the invited guests. The afternoon was devoted to meetings of the numerous conferences with papers and general discussions by those present.

There were present at the convention 210 members and guests, representing fourteen colleges and universities in Illinois and Indiana, the University of Wisconsin, and the numerous junior colleges in and around Chicago.

The 1937 meeting is to be held at the University of Illinois in Urbana at a date to be selected by the Executive Committee.

T. C. SHEDD,
Secretary

The Southeastern Section met at Madison, Wis., June 25, 1936. The meeting was presided over by Dean W. S. Rodman, Vice-Chairman of the Section. Twenty-five members were present.

A. M. White, of the University of Virginia, was elected to represent the Southeastern Section on the Chemical Engineering Committee.

A motion was made and carried to hold the next meeting of the Section at the University of Florida sometime during the winter or spring. The Executive Committee and Dean Van Leer were delegated to determine the time of the meeting.

After a brief discussion of suitable topics for the program, the meeting was adjourned to permit attendance at the afternoon general session.

N. C. EBAUGH,
Secretary

Tufts Chapter of the S. P. E. E. held a long evening meeting devoted to a discussion of changes in the curriculum. These changes were voted at a faculty meeting on Monday, March 16.

Dean George P. Bacon has resigned, the resignation to take effect at the end of the college year. Professor Harry P. Burden has been appointed Dean of the Tufts College Engineering School; Frederick H. Crabtree has been appointed Assistant Dean; and Assistant Professor Jamison R. Harrison has been made Head of the Department of Physics in Tufts College, with the rank of Professor.

FREDERIC N. WEAVER,
Secretary

AN INTERESTING LETTER

During the spring and early part of the summer I traveled, spending some time in the Philippines and in Australia. In the latter country I visited several technical schools and colleges, and the Engineering College at the University of Melbourne. Knowing very little about the English universities, it appeared to me that the Australian universities have fallen into a niche somewhat between English and American schools.

I noticed that grades were not given, everything being for pass or honors examinations, and such things as semester-hours of credit were not used. The engineering curricula appeared much like our own, and many of the texts used were American books.

The technical schools and colleges, however, struck me as offering work more comparable to our terminal courses in the California Junior Colleges. There was more of the trade school idea in them than the idea of a technical college, such as California Institute of Technology, for instance. Each state appears to have but one university, there being no private ones, so that there is but one true engineering college in a state, although there may be several technical schools or colleges.

GILBERT H. DUNSTAN

COLLEGE NOTES

As the opening event of the Horace Mann Centennial Year, **Antioch College** announces a two-day conference on "The Function of Education in a Democracy," to be held in Yellow Springs, Ohio, on October 16 and 17, 1936. The program is being sponsored by the National Education Association in conjunction with the College; the addresses will center around today's need for new education goals. The speakers include: John Dewey, Stephen Duggan, George F. Zook, E. H. Lindley, Mrs. Lillian Gilbreth, Karl T. Compton, and Payson Smith.

Antioch seems especially appropriate as the scene of such an event because the College's first president (1853–1859) was Horace Mann. Although Mann lived only six years after coming to Antioch, he founded in that time a strong tradition within the institution itself, and contributed notably toward the cause of higher education in his day.

The occasion has been made possible to the College through the generosity of an alumnus, Mr. Hugh T. Birch, who as a boy knew Horace Mann. Mr. Birch is presenting Antioch with a figure of the great educator in bronze, a second casting from the artist's original model for that statue of Mann which stands in the Statehouse grounds in Boston. The Antioch statue will be formally dedicated during the conference. A play, "Testament of Faith," depicting Mann's work on behalf of education, will also be presented.

Drexel Institute of Art, Science and Industry—the only college which has adopted the coöperative plan of technical education in the Philadelphia area—is now officially Drexel Institute of Technology, according to an announcement made by the Trustees of the Institute.

The change in name, previously approved by the courts of Philadelphia, has now been formally approved by the Pennsylvania Department of Public Instruction.

University of Michigan.—M. E. Cooley, Dean Emeritus, arrived home September 1 from the Army and Navy Hospital, Hot Springs, Ark., where he had been since February 15. He is now at work on the history of engineering at the University of Michigan.

Northeastern University.—Several new members of the Day Division faculty begin their duties at Northeastern this fall. They are William T. Cloney, Jr., Instructor in English; Laurence B.

Heilprin, Instructor in Mathematics; and Delphin G. McFarland, Assistant Professor of Modern Languages.

Mr. Cloney holds the A.B. degree from Harvard University and has done considerable graduate work in the Harvard Graduate School of Education. During the past three years he has been an English master at the Roxbury Latin School and also a member of staff of the Boston *Herald*. Mr. Cloney will teach freshman composition in the College of Engineering.

Mr. Heilprin received his S.B. and M.A. degrees from the University of Pennsylvania and is at present a candidate for the Ph.D. at Harvard University. He has had considerable teaching experience at both institutions.

Professor McFarland, who is also a member of the faculty of Boston University from which he holds the B.B.A. and M.A. degrees, has spent much time during the last four years in European study and travel. He will teach French and German, assisting Dr. Waldo C. Peebles who came to Northeastern last year.

Dean Ell has also announced the following promotions in rank for members of the Engineering faculty: William T. Alexander from Instructor to Assistant Professor of Industrial Engineering, Asa S. Knowles from Assistant Professor to Associate Professor of Industrial Engineering, Laurence F. Cleveland from Instructor to Assistant Professor of Drawing, and Elmer E. Haskins from Instructor to Assistant Professor of Mathematics.

During the summer a substantial wing has been added to the Engineering Laboratory Building which will house the Biology and Electrical Measurements Laboratories. Dr. Stanley D. Miroyiannis, Chairman of the Department of Biology, has given his entire summer to supervising the construction and installation of equipment for the laboratory and to the selection of necessary instruments, apparatus, and materials. The new laboratory will comfortably accommodate a section of thirty-six students at one time.

General equipment includes simple and compound microscopes, a binocular dissecting microscope, microscopical stains, staining solutions, physiological preparations, reagents, chemicals, and glassware.

The zoölogical collection for the course in General Zoölogy is especially good. It includes a complete series of invertebrate and vertebrate specimens for dissection and also various demonstration specimens. Among these are complete series of sponges, corals, echinoderms, flat worms, annelids, mollusks, a set to demonstrate the general survey of the animal kingdom, and a complete series of Leuckart zoölogical charts.

The histological collection consists of some four hundred mounted microscopical specimens illustrating various forms of in-

vertebrate and plant tissue, while the botanical collection includes a complete series of both preserved and mounted botanical specimens.

About two hundred volumes including principal biological periodicals, standard reference books and monographs comprise the biological library at present.

The Electrical Measurements Laboratory, already well equipped, has been moved into lighter and more commodious quarters and furnished with new tables and permanent housing. The new area is easily accessible from the Dynamo Laboratory which it adjoins.

Considerable equipment is being added also to the Internal Combustion Engine Laboratory including two gasoline airplane engines and several Diesel engines of various types. Among the latter is a 30 H.P. high speed Fairbanks-Morse machine driving a 19 K.W. D.C. generator, an auto truck Diesel, and two small engines for dismantling and demonstration purposes.

A marked increase in the placement of coöperative students is evident this fall. Not only the number but also the type of cooperative jobs reflect a very definite improvement in the industrial situation. Training programs that partially or wholly lapsed during the recent years of severe economic depression are being reestablished with many of the larger coöperating companies.

BOOK REVIEW

Reinforced Concrete. ROBERT A. CAUGHEY. D. Van Nostrand Company, Inc. $3.75.

This book differs from other texts covering the same subject in several respects. It teaches the fundamentals of reinforced without the use of formulas, the derivation of which is undertaken only when the student is well grounded in basic principles. There are two complete sets of problems given in each chapter and problems are given with and without answers.

Composite beams of concrete and structural steel are treated by the author—a subject not covered in other texts.

A brief by complete coverage in later chapters of the Elastic Curved Beam Theory, Moment Areas, Moment Distribution, Conjugate Points and Slope Deflection.

The 1936 Report of Committee 501 of the American Concrete Institute is incorporated in Appendix A and has been referred to in problem and design work. In the case of column formulas where new specifications differ from the old, requirements for design and typical designs based on old specifications are given.

A. DIEFENDORF

CIVIL ENGINEERING DIVISION

L. E. GRINTER, *Chairman*
H. C. BIRD
F. T. MAVIS

K. C. REYNOLDS, *Secretary*
H. E. BABBITT
HALE SUTHERLAND

GROWTH AND POLICIES

BY L. E. GRINTER

Chairman 1936–1937, Texas A. and M. College

The Civil Engineering Division is now well into its third year of growth. Those of us who attended the organization meeting at Cornell in 1934 (as I remember it, there may have been a score of persons present) are both surprised and pleased at this lusty offspring of the old Civil Engineering Committee. The Madison Meeting attracted over one hundred and fifty persons to the sessions on civil engineering, an enthusiasm that would have been quite unbelievable a few years ago.

Perhaps one reason for the interest in the Civil Engineering Division is the large number of persons actively engaged in the work of its several committees. Over eighty civil engineers were in some manner associated with the work of the Division last year. Undoubtedly, this number will be increased somewhat in 1936–1937.

Another interesting feature of the division is that there are many young men functioning on its committees and the committee chairmen have indicated their individual intentions to add still younger men when vacancies occur. The teaching of civil engineering profits from the enthusiasm of young teachers, and the Division will profit from their new points of view.

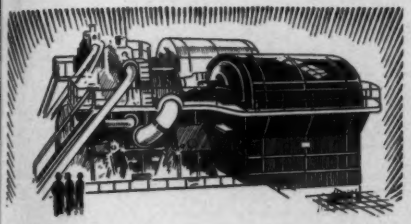
If the policies adopted at the Madison meeting are continued over a ten-year period, a majority of the civil engineering teachers who are members of the S. P. E. E. will have served the division in some official capacity. I refer to the decision that "the number of members on continuing committees shall be multiples of three appointed for a three-year term of office with the provision that a former member of a committee may only be reappointed to the same committee after a lapse of at least one year in such committee membership." I believe that the number of reappointments will be relatively few, so that the result will be to introduce new members annually into the eight standard committees.

The policy adopted also necessitates the change of committee chairmen at the end of the present year and at the end of each succeeding year. Each year the chairman of each committee will select a vice-chairman as his assistant for that year. The following year the outgoing committee chairmen will recommend their successors, but appointments will be made by the incoming chairman of the Division.

Based upon these well defined policies of rotation of committee members and committee chairmen, I believe that the work of the Civil Engineering

Division will continue to be carried on enthusiastically and effectively. Since every member of the Division must know at least one committee member, the Division should remain open to the widest possible source of suggestions from the general membership. It will be our continuing policy to encourage members to offer suggestions, to submit papers for discussion, and to enter actively into the general work of the Division.

G-E *Campus News*



BIGGER AND BETTER TURBINES

THE new 110,000-kilowatt turbine-generator, built by General Electric and recently placed in service in the River Rouge plant of the Ford Motor Company, sets several new records in turbine construction.

It is the first large unit in the world to operate at 1200 pounds pressure and at 900 Fahrenheit. Although weighing approximately 2,000,000 pounds, it occupies less than a cubic foot for each kilowatt of output. Because of its extremely high efficiency, less than a pound of coal generates a kilowatt-hour.

The high-pressure turbine and generator are mounted directly above the low-pressure unit. Superheated steam enters the upper unit at 12 pounds and 900 degrees and, after producing 55,000 kilowatts, flows directly into the low-pressure unit where it produces another 55,000 kilowatts. This is the first 1200-pound turbine in which the steam enters the low-pressure stage without reheating.

COFFIN FELLOWSHIPS

THIS fall eight young men will be carrying on advanced research in seven American universities under fellowship grants from the Charles A. Coffin Foundation. The recipients:

George E. Boyd, U. of Chicago '33. At Chicago.

Lyman R. Fink, U. of California '33. At California. Second grant of fellowship.

Alvin H. Howell, U. of Kansas '29. At M.I.T.

Russell A. Nielsen, Stanford '33. At Stanford.

Richard W. Porter, U. of Kansas '34. At Yale. Second grant.

Julian S. Schwinger, Columbia '36. At Columbia.

Chauncey Starr, R.P.I. '32. At Harvard. Second grant.

Harold G. Vogt, U. of Buffalo '31. At Harvard.

Since 1922, when the General Electric Company established the Charles A. Coffin Foundation in honor of the Company's first president, 113 fellowships have been awarded for advanced work in electricity, physics, and physical chemistry.

ELECTRIC HEAT FOR SOILLESS GARDENS

CALIFORNIA nurserymen are growing tomatoes, strawberries, and sweet peas in chemically treated water heated by electricity. The method, developed by Dr. W. F. Gericke, of the University of California, has been extended to commercial installations. Tomato plants, grown in this way, produced unusually high-quality tomatoes. The yield was large, and they matured ahead of tomatoes grown in soil.

Nourishment is provided by special chemicals dissolved in the water. Because the water temperature must be accurately maintained, a controllable heat source is required, and General Electric engineers have supplied heating cable and thermostats both for the experimental installation and for commercial installations which have followed.

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(Volume I: Statically Determinate Structures. 320 pp., Illus., $4.00 probable. To be published late October or early November)

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